Printed on thin paper for overseas circulation.

Engineering Library

The Engineer

VOL. CLXX.—No. 4419 28, ESSEX ST., STRAND, LONDON, W.C.2 SEPTEMBER 20, 1940

Established 1856 Price One Shilling, by Inland Post 1s. 3d. Registered as a Newspaper

S & L

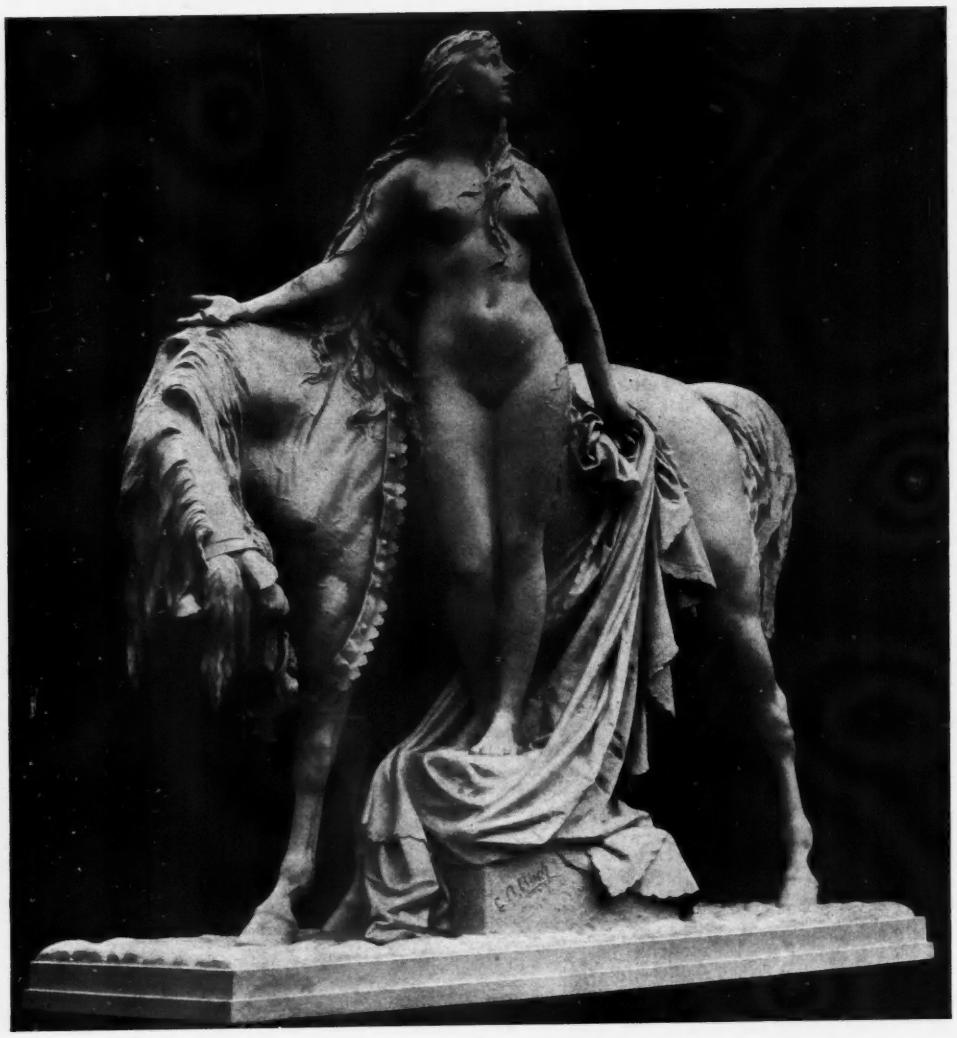
OCT 9 1940

STEEL TUBES

STEWARTS AND LLOYDS, LTD.

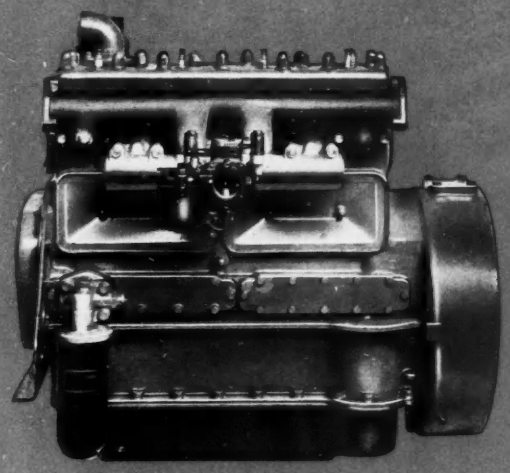
GLASGOW · BIRMINGHAM · LONDON

& FITTINGS



"Then she rode forth, clothed on with chastity...
and built herself an everlasting name"—

"GODIVA"



COVENTRY CLIMAX "GODIVA" Type F.A. Engine

COVENTRY CLIMAX ENGINES LTD. GODIVA

Coventry and Godiva and Service are words which strike a sympathetic chord in the mind, and in adopting the name GODIVA for our products we pledge our whole energies to maintain this capacity for supreme service in the engines, fire engines and equipment we produce.

COVENTRY CLIMAX ENGINES LTD.
(Dept. S.), COVENTRY, ENGLAND - *Telephone 5051.*

INDUSTRIAL & AERO ENGINES, FIRE ENGINES, GENERATOR SETS, Etc.

H.P.

A Seven-Day Journal

North-Western Area Supply Board

REFERENCE has already been made in these columns to the decision of the Ministry of Supply to strengthen the Area Supply Boards. An announcement is now made regarding the completion of the North-Western Area Supply Board, which serves the district around the city of Manchester. The Board, which consisted of Mr. J. W. Frost, of the Union of Foundry Workers; Mr. F. Siddall, of the Amalgamated Engineering Union; Admiral Robins, representing the Admiralty; Sir Thomas Barlow, the Board of Trade; Mr. H. N. Grundy, the Ministry of Labour and National Service; Admiral Turner, the Ministry of Supply; and Sir Ernest Simon, the Ministry of Aircraft Production, has now been increased by the following appointments:—Sir Frederick J. West, of West's Gas Improvement Company, Ltd.; Mr. G. E. Bailey, of the Metropolitan-Vickers Electrical Company, Ltd.; and Mr. D'Arcy Hadden, of Hick Hargreaves and Co., Ltd. The Vice-Chairman of the Board is Alderman Luke Hogan, of the National Union of Distributive and Allied Workers. The main functions of the Area Board, we may recall, are to utilise knowledge of local industry to ensure that its capacity is fully employed, to assist in sub-contracting to see that the export trade occupies its proper sphere, to provide an organisation to deal with affairs and reconstruction from damage arising from aircraft activity, and generally to co-ordinate the activities in the district arising from the requirements of armament production for the Admiralty, Ministry of Supply, and the Ministry of Aircraft Production. All communications intended for the Area Board should be addressed to the Secretary, Mr. C. T. Dean, 11, Piccadilly, Manchester. It is pointed out that the success of the scheme is dependent on the readiness of the prime contractor to sub-contract all suitable work, and the Board will be grateful if prime contractors would review their order book and ascertain whether they have any work which they could sub-contract. Firms who can offer capacity for sub-contracting work are asked to get into touch with the Board.

The Late Thomas Roles

POWER station engineers the world over will hear with sorrow of the death, on September 9th, of Mr. Thomas Roles, whose work at the Bradford power station gained the applause of all progressive engineers. He was the first man in this country to adopt really high pressures and temperatures for municipal electricity supply. It was in 1930 that the extension of the Valley Road Power Station, Bradford, was completed with a boiler and turbine designed for 1100 lb. pressure at a temperature of 800 deg. Fah. The nearest approach to those steam conditions in this country at that time was to be found at the I.C.I. 850 lb. plant, and the Ford 1250 lb. plant was in contemplation. But Roles, following American and Continental examples, had the honour of being the first to use a super-pressure in a public utility service in this country. What he did was to "compound" the existing 200 lb. plant at Valley Road by employing a turbine which could exhaust at a pressure of 205 lb. into the existing mains. The whole plant was British throughout and, as we remarked in a leading article at the time, "we have now had taken from us the reproach of having nothing of our own to talk about when very high-pressure steam is under discussion." "Tommy" Roles, as his friends loved to call him, was barely sixty-four years of age. He was educated at the Brighton Technical School and was an Old Cromptonian. After some years' experiences in various power stations he became in 1904 assistant to the Chief Electrical Engineer, Bradford Corporation, and three years later was promoted to be the City Electrical Engineer and Manager.

German Air Losses

IN his statement in the House of Commons on Monday of this week, Mr. Churchill said that neither side as yet had employed more than a proportion of its aerial forces, but that there were good reasons for believing that crushing inroads were being made into the enemy's superiority of numbers. Referring specifically to the air engagements fought over this country on the previous day, Sunday, he described them as constituting the most brilliant and fruitful action fought up to the present by the fighters of the Royal Air Force. On that day 187 raiders were destroyed. Mr. Churchill stated that he had made searching inquiries and taken several cross-checks, and as a result was satisfied that the figures were not exaggerated in any way. It is well known that the British returns of enemy losses take no account of "probables," but only include "certainties." On that subject it may be noted that before a pilot can claim a "certainty" he must see his enemy actually crash on the land or sea. Earlier in the war this ruling frequently led our pilots to follow their prey downwards to make sure that it eventually crashed and became a certainty. This practice is now somewhat in disfavour, as it has been found that it does not pay to be too curious as to the ultimate fate of a raider which plunges earthwards. With scores and even hundreds of fighters accompanying enemy bombers, whole squadrons can be spared by the Germans to wait aloft above the main battle ready to swoop on any of our fighters which becomes separated from its fellows or which seeks to follow an antagonist downwards to make sure of its fate. Our pilots are therefore learning that if they see an enemy going down in smoke it is better to regard it as a "probable" than to take steps to ensure that it can be marked down as a "certainty." As a consequence, the official figures for enemy losses are to-day in all likelihood even more cautious and conservative than they were in the earlier days of the war.

The American Destroyers

AN ingenious solution of the problem of naming the fifty American destroyers acquired by Great Britain has been found. Mr. Alexander, First Lord of the Admiralty, informed the House of Commons on Tuesday last that an agreement had been reached between the Government of the United States and the Government of Great Britain that the original names of the destroyers should not be retained and alternatives had been carefully considered. It was decided at last to give them names common to towns and villages of both countries. That was a very happy idea, and there is an abundant supply to draw upon for all the ships. There are, Mr. Alexander said, a few names common to the West Indies, and they would be used for some of the vessels. The names so far approved by the King are Churchill, Caldwell, Cameron, Castleton, Chelsea, Chesterfield, Clare and Campbeltown. There were cheers in the House when Mr. Alexander announced the first name in this list. It may interest our readers to know that the American town called Churchill is in Maryland. The remaining names are to be announced shortly.

Higher Railway Charges Inquiry

THE public inquiry into the proposed increase in railway fares, held by the Charges (Railway Control) Consultative Committee, was resumed on Wednesday, September 11th, at Brooklyn Hall, Bush House, Aldwych, under the chairmanship of Mr. W. Bruce Thomas, K.C. Speaking on behalf of the London Transport Passengers' Alliance, Mr. Harold Heath claimed that the application of the companies was a scandal. He contended that that part of the population encouraged by the Government and carried by the railways to live in the suburbs would be driven to giving up their homes and going back to the towns because of the added burden of increased fares. The companies were out, he said, for more than they were entitled to. Parliament would, he considered, have to terminate the agreement with the railways. On behalf of the Amalgamated Union of Upholsterers Mr. G. F. Shanley, the Secretary of the Union, said that men in that industry had to pay 3s. 6d. in fares out of their unemployment pay in order to look for work, as the industry was centred in the City of London. Another speaker for the London Transport Passengers' Alliance, Mr. Fruit claimed that the railway companies had always opposed cheap fares. Replying for the Railway Executive Committee, Mr. Alfred Tylor, said that the companies still adhered to the view that a flat rate increase was the best way of meeting the extra working costs. The Chairman, Mr. Bruce Thomas, K.C., concluding the inquiry, said that the Charges (Railway Control) Consultative Committee would consider the evidence given during the inquiry, and would make its report as soon as possible.

The Late Sir Harold Carpenter

SIR HAROLD CARPENTER, F.R.S., who died in tragic circumstances at the end of last week, enjoyed a world-wide reputation as a metallurgist. He was the joint author with Dr. J. M. Robinson of one of the most important works on his own subject—"Metals," 1939—and for twenty-five years was Professor of Metallurgy at the Royal School of Mines, South Kensington. In 1918 he was made a Fellow of the Royal Society and in 1929 was knighted. He was a Past-President of the Institute of Metals, of the Institution of Mining and Metallurgy, and of the Iron and Steel Institute, and Chairman of the Metallurgy Research Board of the D.S.I.R. He received numerous prizes and medals from British and foreign countries, anongst which may be mentioned especially the Carnegie Gold Medal (Iron and Steel Institute), the Bessemer Gold Medal, and the Platinum Medal of the Institute of Metals. He was moreover a Corresponding Member of the Swedish Royal Academy of Scientific and Industrial Research, an Honorary Member of the American Institute of Mining and Metallurgical Engineers, and was a Carl Lueg Laureate of the Verein Deutsche Eisenhüttenleute. We mention these distinctions to show how widely Sir Harold Carpenter and his work were recognised. He was born in 1875, and one of his Christian names, Cort, signalises the fact that he was descended from Henry Cort, the inventor of the puddling process. He received his education at St. Paul's School, at Merton College, Oxford, and at the universities of Leipzig and Manchester. He was the first head of the Chemical and Metallurgical Departments of the National Physical Laboratory and, as already mentioned, held the Chair of Metallurgy at the Imperial College for a quarter of a century. Amongst his publications are many papers and research reports presented to various learned societies.

Work and the Siren

THE Government is confident that all employers and workers on essential work, including export trades, will be willing, wherever possible, to carry on after the siren until it is clear that enemy attack is imminent, and to resume work when the immediate danger has passed, without waiting for the public "Raiders Passed" signal. Henceforth the warning by siren is to be regarded as an "Alert" and not as an "Alarm" signal. Working after the siren clearly involves risk, and to keep down the risks involved it is essential that watchers should be posted on roofs or other vantage points to give warning of danger, and that protection should be provided at or near the actual work places. Whatever arrangements are made, the Government emphasises, should be the result of discussion between the management and the workpeople concerned. Working after the siren will not affect workers' rights to compensation for personal injury under the Government scheme, or their rights under any known life insurance policy which covers war risks; nor does it affect the employers' position under the Personal Injuries (Emergency Provisions) Act. It is suggested that watchers for duty by day or by night should be selected by agreement between the management and the workers; that the arrangements for stopping work and taking shelter and for resuming work before the "Raiders Passed" signal are matters for adjustment between the management and the workpeople; and that a watching system can apply to outdoor work as well as to work in factories. Owing to the different types of factories and the great variety of products manufactured, each establishment must work out its own plans. Different parts of the same factory may also require different treatment. For general guidance, the Government has issued the Air Raid Precautions Memorandum No. 16, obtainable from H.M. Stationery Office, showing in detail the sort of things that should be attended to and how best to attend to them, such as the treatment of glass—which calls for particular attention—and arrangements by which the workers can take immediate cover by lying down behind traverse walls or behind plant or material near them or in pits or sub-floor ducts.

London's Water Buses

A THAMES river service, which ten years ago was stoutly championed by Mr. A. P. Herbert, but was not realised, has come into being as a war-time measure. On Thursday, September 12th, the Ministry of Transport announced that on Friday, the 13th, a passenger boat service between North Woolwich L.N.E.R. Pier and Westminster Pier, calling at Brunswick for East India Dock, Greenwich, West India Dock, Thames Tunnel, Wapping, Cherry Garden, Bermondsey, and the Tower Piers, would be started. The service is to be operated each day, Sunday excepted, and on Friday it started with a forty minutes' interval service, which on Monday was increased to a twenty minutes' interval service. The first boat leaves Woolwich and Westminster piers in each direction at 6.30 a.m., and Greenwich in each direction at the same time. The last boats leave Westminster at 4.30 p.m. for Woolwich, and for Greenwich and intermediate points at 5.10 and 5.50 p.m. The last boat leaves Woolwich for Westminster at 5.10 p.m. and for Greenwich and intermediately at 5.50 p.m. Tickets are issued on the boats and railway seasons and bus or tram return tickets (including workmen's return tickets) are valid for the appropriate journey. The service has been successfully begun with different types of Thames pleasure launches, such as we have come to associate with such services as those to Hampton Court and Twickenham, with carrying capacities of from 80 to 250 persons. The full fare is 9d. return, or 7d. for a workman's ticket and railway season tickets are available. The fares are collected by a bus conductor of the London Passenger Transport Board.

Further North American Locomotive Experiences

By EDWARD H. LIVESAY

No. I

INTRODUCTION

MY Scottish locomotive experiences, dealt with in THE ENGINEER last year, began with the old adage "Great trees from little acorns grow," which signified that, when I left Vancouver in a locomotive cab two years ago, I never realised how far afield the action would take me, and what a variety of interesting locomotives it was fated to bring me into contact with. It was hoped that France would be the next country visited, but the neurotic paper-hanger upset that plan. However, he could not prevent a recrossing of the Atlantic to Canada and the States, where railways have not as yet been affected by the European tragedy. I am therefore asking the reader to bear with me again if I make a few additions to the first series of articles, which had North America for its field, and to allow me to take him back across the Continent to Vancouver, my original starting point. The tree that grew from that little chance seed still flourishes, and has apparently not attained full stature yet.

A word or two of explanation is necessary before beginning this series. The transcontinental journey on which it is based was productive of so many interesting experiences that it is quite impossible to cover them all, and space limitations in THE ENGINEER owing to the paper shortage impose still further restrictions. The conundrum, what to describe and what to pass by, has been throughout as exasperating as a recurring decimal—there could be no final, satisfying solution. So I have had to rest content with a partial answer to the problem; one that has taken the shape of articles in which outstanding locomotives are shown doing work that has been chosen for description, as far as possible, for the reason that it is largely dissimilar. Express services, steam and Diesel; freight, secondary, and mountain trains—all go to make up the picture. As I have said, much work well worthy of attention has had to go unrecorded. What remains can be termed the cream of the tour, which extended to nearly 10,000 miles, and took me from the Atlantic to the Pacific, there leaving me to do my best with the mass of material gathered *en route*. Though the journey actually began at St. John, N.B., the first part of it thence must be omitted, the starting point assumed to have been Montreal, and the first run with

"THE INTERNATIONAL LIMITED," C.N.R.

This famous train has been running since the beginning of the century, and is one of the best known on the North American Continent. It operates between Montreal and Chicago, *via* Toronto, Hamilton, London, and through the Sarnia tunnel, the distance covered being 849 miles. It is fast and heavy, often weighing over 1000 tons, and though there are no spectacular gradients to be overcome, they are quite frequent over some sections, accompanied by considerable curvature, and there are several stops. A few years ago it was the fastest train in the world over a considerable distance, the 334 miles from Montreal to Toronto taking only 360 min., the result of keen competition between the C.N.R. and C.P.R. The two companies have since buried the hatchet, at any rate so far as this service is concerned, and the schedule is now 30 min. longer. It is literally an international train, running over Canadian territory to Sarnia, under the St. Clair River, and thence over United States metals to Chicago. The engines employed between Montreal and Toronto, the only section that I can deal with in this article, are of the 4–6–4 and 4–8–4 types, designed by Mr. Roberts, the C.M.E. of the C.N.R., and are fast and powerful machines. The 4–6–4 "Hudsons" are unusual, in that they are what is known in America as "high-wheel" engines, and were specially designed for fast travel in the competitive service I have mentioned. Until the arrival of Mr. Bowen's 4–4–4 "3000" class, C.P.R., no other Canadian engines had such large driving wheels, and I was glad to have an opportunity of watching their performances on this outstanding train.

The chief dimensions of the "5700" class are as follows:—

Cylinders	23in. × 28in.
Valves	12in. diam.
Travel	9in.
Boiler:	
Diam. inside	78in. and 86in.
Length between tube plates	19ft. 1in.
Steam pressure	275 lb.
Heating surface:	
Tubes and flues	3032 sq. ft.
Firebox and arch tubes	345 sq. ft.
Total	3377 sq. ft.
Grate-area	73·6 sq. ft.
Tractive effort, main cylinders	43,300 lb.
Booster	10,000 lb.
Weight:	
On drivers	188,600 lb.
Engine	356,400 lb.
Tender	305,800 lb.
Total	300 tons (long)
Coal	20 tons
Water	14,000 galls.

Baker-Pilliod valve gear. "Standard" stoker. Franklin booster and butterfly fire-door. Skefko Roller bearings on trucks and tender, which is of the Vanderbilt type.

I picked up the engine "No. 5700" (Fig. 1) at the Turcot yard, where the train is made up of both C.N.R. and C.P.R. stock; the Toronto service being "pooled." It was backed over the several miles to the C.P.R. Windsor Station, from whence the start was made punctually at 3 p.m., in a drizzle; the booster's help on treacherous rails was welcome. There were nine cars, weighing loaded about 750 tons; acceleration was good, without any slipping, the booster joining in, and raising the tractive effort to 53,300 lb.; the throttle was three-quarters open and the cut-off 75 per cent. The enginemen, Messrs. Riley and O'Brien, considered the load light; 1400 tons have to be handled on occasion. The booster was cut out at about 8 m.p.h., which reminds me that in one of the first "North American" articles I put the cutting-out speed at 25 m.p.h.; I apologise. Two suburban stops were made in the first 4·7 miles, and a slowing to 10 m.p.h. at Dorval, where the C.N.R. track is joined and real running begins.

At Point Claire, 14¾ miles, the speed had risen to 65 m.p.h., and both the engine and the occupants of the cab had settled down to their jobs. There was no speed indicator fitted, so figures are only approximate. The cab appealed to me strongly. It was of the vestibule type—that is, entirely enclosed—and its generous width, upwards of 11ft., and four comfortable leather-cushioned seats, with window-ledge arm rests, made it seem luxurious—even palatial—after the more austere accommodation I have become used to in England. The "Standard" stoker, and adequate ventilation, made it clean and only comfortably warm; the fittings were well arranged and convenient, both to see and reach. The gauges were in two groups, electrically lighted, the engineer's consisting of (1) Ashcroft—steam and exhaust—pressure; (2) and (3) brake, one for reservoir, the other train line; (4) booster. The fireman's were (1) steam pressure; (2) stoker; (3) steam heat and air signal; (4) exhaust injector. There is no feed-water heater on these engines, an exhaust steam injector (Hancock) being used in lieu to save weight, which is unusual in America, where the feed heater is almost standard. All vital fittings were lighted, including the stoker lubricator; the throttle was of the hanging type, held by catch and ratchet; the reverse air operated, as also was the whistle, by a trigger below the reverse wheel. It is sounded very frequently in older settled districts such as we were running through, owing to the number of level crossings.

A wind scoop will be noticed round the chimney (Fig. 2). It is probably some good, but not much, I should say. This has been tried in Europe and discarded; side plates are better, and are now coming into considerable use in America. Down-drifting steam can be a great nuisance, but it gave only a little trouble on this run, as the engine was working fairly hard. The damp air, due to the waterlogged fields, snow patches, and rain, and the resulting condensed steam were unable to upset the look-out seriously, partly because the Kent revolving window was installed on the engineer's side. This is admirable; quite the best "clear vision" device I have seen. It is simply a circular window, kept spinning at high speed in contact with a scraper. Nothing can dim it or stay on it; it is a window wiper to conjure with, and it amazes me that I never thought of it myself! It has, I was told, the additional merit of being English.

Coteau—38 miles—was passed at 3.53 p.m. on time; we were running parallel with the St. Lawrence River, over a water-level route, with easy gradients. The colour-light automatic signals were very bright and well placed, but the absence of the Kent window on the fireman's side made it necessary for me—and him—to look for them through the glass deflector strip at the cab side, as the front window was useless, covered with soot and rain. The engineer's, spinning dizzily, was quite clear. The speed was generally about

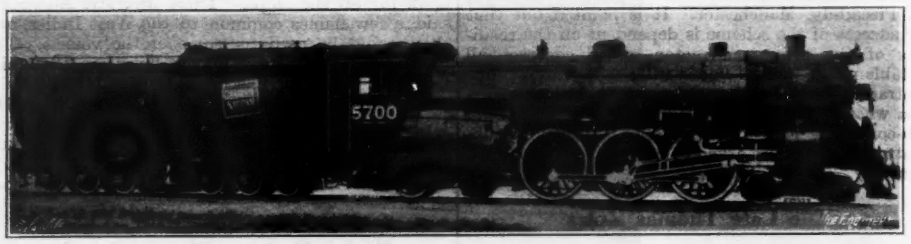


FIG. 1—CANADIAN NATIONAL 4-6-4 LOCOMOTIVE

70 m.p.h., with the throttle two-thirds open and cut-off 35 per cent. or less. The riding was good, allowance being made for the winter's frost coming out of the road-bed—it is not always considerate enough to come out evenly. The action of the driving mechanism was unobtrusive, though the "5700" class is not cross counter-balanced, but the pistons are only 23in. in diameter, and the crossheads, being commendably light, balance weights and hammer-blow are alike moderate.

After Riviere Beaudette, along some straight track towards Lancaster, miles were being covered in 47 sec., about 77 m.p.h., I had to stand up to

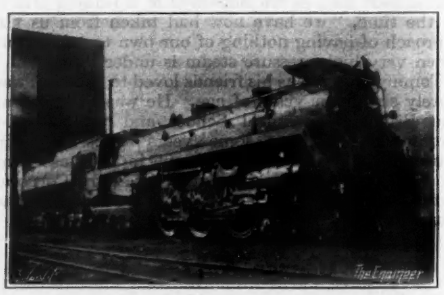


FIG. 2—No. 5700 SHOWING WIND SCOOP

write, so evidently some bumping was going on, but nothing excessive. A sharp S bend near Summerstown imposed a speed restriction, shortly after which we came to a stand in Cornwall at 4.20 O.T.; 67·6 miles in 80 min., with two intermediate stops, and the 10 m.p.h. Dorval slowing. The 53 miles from Point Claire to Cornwall had been covered in 50 min., an average of roughly 62 m.p.h., quite good with a 750-ton train. Water was taken and a restart made in 3 min.—quick work. The getaway was very rapid, with fine acceleration up the Hog's Back, a steep gradient to Mille Roches. I cannot give the inclination, as profile books are apparently non-existent on this side of the Atlantic, and the enginemen seldom know gradient figures. We were making 50 m.p.h. over the peak at Mille

Roches, 3·5 miles from Cornwall, covered in under 7 min.; after this there was a descent, and the speed rose to over 75. It showed little variation as a rule—70–75 was generally held. Iroquois was passed at 4.55 p.m. and Prescott, after slowing for a nasty curve, at 5.05 p.m., dead on time.

I am always interested in the mechanical stoker, and impressed by the perfect way in which it does its work. I watched it closely on this run. It is anything but the crude and wasteful device one is apt to think it—until one sees it at work. Ideas about it alter quickly then. So far from being a necessary evil, I am convinced that it does a much better and more economical job than the most skilful fireman can achieve with a shovel. Instead of an intermittent feed, varying from nothing to too much, and seldom exactly right, a steady, continuous shower of fuel is sprayed into the four corners and centre of the box, after being crushed by the conveyor, to burst into flame directly the steam jets pick it off the shelf below the fire door, on to which it has been pushed. The fire is always level, and of an even thickness. The quantity of fuel can be exactly regulated, and directed just where it is wanted by the five jets and a deflector plate. The fire door is not being frequently opened and closed, thereby temporarily upsetting the air supply. It remains shut, so the air supply, once adjusted, remains correct. The more I see of the stoker, the more its good points impress me. Besides, my sympathetic soul is not distressed by watching the fireman fight a never-ending battle, trying to satisfy the insatiable appetite of a ravening fire-box. This is the twentieth century; make machinery do the work, not muscle; let the fireman sit on his posterior, turn a wheel or two, talk to me—and send his shovel to a museum. I should like to say more about the stoker, but space forbids. Perhaps I may be able to do so in a later article.

The next stop was Brockville, at 5.17 p.m., 3 min. early, the 58 miles from Cornwall having been covered in 54 min. The crews changed here, Messrs. Muirhead and Carey taking over. The grate was rocked—for the first time—and the "once over" given to the running gear, &c. The restart was made at 5.30 p.m., but was followed by a stop just outside the station for coal, taken on in 3 min.—very snappy work. We finally got away at 5.35 p.m. We were out of Quebec now and well into Ontario, and the weather was dull and dry. The country was rougher, more rocky, and curves frequent. The riding was rougher too. The speed remained 70–75, however, with an occasional touch of the brake round the many bends; level crossings were incessant, the deep-toned whistle sending out its warning—two longs, a short, and a long—at them all. Rock cuttings were much in evidence, and I find in my notes: "After Brockville far more curvature—riding much rougher—rock foundation of track hard to keep right." Kingston, the military centre, was the next stop, at 6.21, where water was taken. A very rapid restart was made at 6.26, 1 min. late, and then what I find noted down as "ruthless running" followed. That means we were a little behind time; gradients, curves, and a bumpy track were trying to hinder "No. 5700" still further, but were not allowed to do so—to hell with 'em—let her have it! Engines are not nursed in America; if necessary, they are thrashed mercilessly. "No. 5700" was getting a bit of a caning along here, in spite of which Napanee was passed through at 6.52, 2 min. late. My notes say: "Rough bit of work from Brockville!" It had been. I never trouble to note a thing like that except for good reason. We were running into the sunset now, the headlight was switched on, and I began to have my usual trouble in making notes, though a good cab lighting helped considerably. A stop for coal and water was made just before entering Belleville, at 7.10, so the 47 miles from Kingston had been covered in 44 min. The grate was shaken—it is in two halves, and the job is quite strenuous when the bars are stuck with clinker—ash-pan cleaned, &c., the work being done by a ground crew, and the time taken 6 min. Then on into the station, leaving again at 7.24 p.m., on time, with a third crew, Messrs. Crozier and Clark.

It was quite dark by this time. My notes were mostly made by the white light coming through the row of holes on the stoker, used for inspection and to admit air, through which the coal can be seen moving slowly on to the shelf below the fire-door, to be suddenly caught up as if by invisible hands and whirled in a dizzy dance to cremation on the grate. Trenton Airport was pointed out to me, a blaze of light; strange, this absence of black-out, to anyone fresh from England. But in the roaring cab the war seemed in another world, though the news of the invasion of Denmark had just come through, and we had been talking about it. Still, we had our jobs to do, and they had first call on our attention—even the war must wait *pro tem.* At Port Hope there was a 1 min. stop at 8.12, and I retired to the dining car for supper, rejoining the engine at Oshawa, from which place we pulled out at 8.50, 3 min. late.

During the run I had been watching the gauges fairly closely. The steam chest pressure was, with the usual two-thirds throttle, about 200 lb. When the throttle was opened full, as at starting, it shot up to over 250 lb. The Ashcroft showed the exhaust pressure to be somewhat high, even 15–20 lb. at times; but I disliked drawing attention to this, as it can indicate improper handling. Tact is advisable in the cab! Sludge was blown every 30 miles, and one of the engineers admitted that "No. 5700" was not riding well, as she had not been shopped for a considerable time. I had guessed this; it did not seem that all the bumps could be due merely to the frost coming out of the ground.

And so this very interesting run, on a fine engine, went on, and neared its finish. After the last stop at Danforth, on through the myriad lights of suburban Toronto, "The International Limited" came to a stand in the Union Station at 9.30 p.m., right on time. The 334 miles from Montreal had been covered in 390 min., at an average speed of 51·5 m.p.h., which included nine station stops and several others for service reasons. The actual running time was approximately 349 min., an average of over 57 m.p.h., making no allowance for slowings and regaining speed. This is good work with a 750-ton train, disappointing only to the enginemen, who looked on the load as light. If it had been about 1400 tons, as it sometimes is, they said, things would have been much more interesting. No doubt; I have yet to try out a 1400-ton express train.

In previous articles I have drawn attention to the greater margin of boiler power provided on American engines than is the rule in England, and here is a case in point. "No. 5700" had two 23in. cylinders, a heating surface of 3377 square feet and a grate area of 73·6 square feet. You can thrash an American engine if necessary, and "get away with it"; but it is not so easy with a British locomotive. The runs I had with "No. 6202," the L.M.S. Turbomotive, illustrate this. Leaving Liverpool with the pressure 90 lb. down, it took an hour and a quarter's running to get it up to concert pitch. Had "No. 5700" left Montreal similarly handicapped, I imagine a much shorter time would have been needed to rectify things. The stoker would merely have been stepped up a little, and perhaps a trifle more attention paid to what it was doing, and in 15 min. or so the safety valves would have popped—not by the sweat of the fireman's brow, either. That stoker—I am all in favour of it, and wish some English company would try it out. Did I hear a rumour, just before I left England, that someone was going to do so? Or was it the thermo-siphon? In the light of my regard for these devices, "someone" can safely go ahead with either—or both!

Summing up my impressions of "No. 5700," I was very pleased with her. A powerful, fast, and free-steaming engine, easily capable of much heavier work than was imposed on her by a 750-ton train. The riding was good, allowance being made for the rough track resulting from the frost coming out of the road-bed. It should be remembered that next to nothing can be done to the track in Canada during the winter; everything waits for spring. Rails are short—40ft., I believe—and the joints are staggered. Steam was always near popping-off point, thanks to ample boiler power and a mechanical stoker. The exhaust steam injector, rather unusual in Canada, did its work perfectly, and was well spoken of. Mechanical lubrication to cylinders and valves (Wakefield, I think), and grease to the driving axles was the method used on "No. 5700," with roller bearings on trucks and tender. The Baker valve gear is somewhat similar to Walschaert's, except that a bell crank takes the place of the link. It gives an equally good steam distribution, but it is said that when wear develops in the pins normal valve travel is affected to a greater extent than with the latter type. It is in extensive use in America, but is not universal by any means.

The Ashcroft exhaust pressure gauge was very informative, and interesting to watch. Some engineers (*Anglice:* drivers) swear by it. Others swear at it—probably those who are apt to be a little careless of their interrelated throttle and reverse wheel positions. I did neither; I merely studied it, sometimes wondering if an indication of 15 lb. or 20 lb. pointed to a careless gauge or a careless engineer. If I summoned up enough courage to ask, it was always the former. I should explain that I am not singling out "No. 5700" in this; it applies to all Ashcroft-fitted engines that I have been on. There seemed big variations; 15–20 lb. struck me as being a little on the high side, and "gave furiously to think" of back pressure, coal consumption—of the Turbomotive softly whispering—of "No. 5700," angrily roaring. But this was Canada, where perhaps coal consumption does not matter so much as in England.

The cab, its spaciousness, comfort, and well-arranged controls, all alike were above criticism, unless the fitting of the "Kent" window on the engineer's side only can be called in question—probably a matter of cost. (A fireman's eyes are not worth as much as an engineer's.) The seats, with cushions and arm rests—how can I adequately give thanks for these boons? No corns showed up anywhere, and they were as comforting as the good fellowship of the crews.

I should like to deal with the continuation of the run to Chicago, but space limitations forbid. From Toronto to Sarnia it was made on a "Pacific," with a much lighter load; thence under the St. Clair River electric traction was used to Port Huron, where American soil was reached, and again a "Pacific" carried on to Chicago. The Montreal-Toronto section was the most interesting part from a locomotive point of view. As usual, I have to acknowledge gratefully the kindness of everybody concerned, from Mr. Roberts and Mr. Connal, down through foremen and enginemen. I have got them all on my list.

(To be continued)

Some Factors Affecting Economic Production

By J. B. SAMSON, A.M.I. Mech. E., A.M.I.A.E., A.R.Ae.S.

General

THE need for economy and rationalisation in the use of materials cannot be too highly emphasised at the present time, and to those concerns (they are many) engaged upon a variety of work utilising varied steel grades in the execution of their commitments under war conditions the necessity for investigation and the institution of a system or procedure to bring about more rigid works control of material issues and balance records is of paramount importance. The adoption also of a works procedure to co-ordinate the activities of production supervision with progress in an effort to effect maximum output in the machine hours available makes necessary a thorough knowledge of the peculiarities of the product, and around which peculiarities must be built an efficient system entailing a minimum of clerical work and labour, yet giving firm control.

Pre-planning is the *sine qua non* of successful economic production, and the knowledge of machine hours worked against capacity available in advance of the weekly sanction issue is vital.

Technical anomalies are mentioned in the body of the article, the removal of which would also be conducive to high output.

Where no well-defined procedure is in operation it is hoped that this article will serve to give a fillip where it is most needed.

Standardisation

The number of different steels in use in industry is rather staggering and gives rise to irritation in

many directions, and in consequence general inefficiency. Not only is the steel maker inconvenienced by the varied mixes and treatments necessary, but the user, too, has his share. It can be readily appreciated that in the manufacturing departments whose duties are concerned with the machining and grinding of component parts from bar, tube, forging or strip material, specification variation raises many difficulties.

In the machine shops, cutting tool angles, feeds and speeds often require adjustment to obtain best conditions for efficient removal of stock.

In the grinding department, grit and grade of wheel, wheel feed, wheel and work speeds require special attention to obtain the desired finish.

In the heat treatment department, apart from the number of heat treatments due to the variety of steels in common use which directly affects furnace capacity, experience has shown errors having occurred in the selection of steel for issue, and these have not become apparent until the heat treatment stage or till later at final view.

In no less degree of importance comes the cutting fluid (which is primarily employed to prolong tool life) and its stability. The trend towards surface finish standardisation makes this of increasing importance. The getting down to closer limits makes necessary a cutting fluid having coolant as well as lubricating properties, the ratio being dependent upon the material being worked and the class of finish desired. The effect of the coolant on the machine itself must not be lost sight of from the detrimental effect on working surfaces, such as slides, &c. Care, therefore, must be exercised in cutting fluid selection, and without doubt a case for standardisation presents itself.

It is manifest also in the effect on the estimating, planning and rate-fixing departments, particularly the latter, whose just setting of job times and prices directly concern ease of output and general satisfaction.

The formation of a research committee consisting of engineers and metallurgists to bring about standardisation in this country by initiating tests in some of our research laboratories must, in the opinion of the author, be considered of crucial importance to industry as a whole, as well as a national asset at the present time.

Steel standardisation, it is worthy of note, is already in use in the United States of America (S.A.E. Standards) and in Germany (D.I.N. and Stahl. U. Eisen Standards).

External and Internal Control of Material

Usually the buyer has under his jurisdiction that section known as materials control, whose head is responsible to the buyer for its efficiency. Close touch must be kept with prevailing market conditions and current prices, such that purchasing can be made to advantage. Since factory material stores are directly connected with materials control section, it is usual, though not essential, for control to be assumed by the buyer.

Adequate records must be to hand, up to date and carefully maintained, of :—

(1) Stocks carried on maximum and minimum basis where conditions allow for this to be done.
(2) Material on order and delivery dates.
(3) Material booked for orders on hand.
(4) Balance at end of each day.

Alford states in his volume on " Laws of Management Applied to Manufacturing " :—

" The highest efficiency in the utilisation of material is obtained by providing the required quantity, of the required quality and condition, at the required time and place."

This, then, should be the guiding star or target to be aimed at by materials control. The exigencies of present conditions make exactitude in records keeping an absolute necessity to the successful management of materials handling. Full advantage should be taken of a suitable card system and signals for statistical records.

The withdrawal of material from the stores is accomplished by the presentation of a material withdrawal requisition by the progress man to the storekeeper, sufficiently far in advance to enable the preparation of the material to be made. In this connection pre-planning of manufacturing sanctions and their issue is vitally important in so far that the material position can be ascertained, machine and gauging equipment checked over in advance, thus facilitating trouble-free " change-overs " by bringing to light deficiencies.

The machine loading position and responsibility for work allocation should advisedly be dealt with under the planning engineer's supervision, that sub-section being termed production control.

The family tree, Fig. 1, indicates the main tie-ups of the planning engineer. It is not, however, intended to indulge in a fully detailed analysis, as Fig. 1 is considered self-explanatory.

Before purchasing of material can be proceeded with materials control must have knowledge of requirements from production control. The pre-planning of work through the sequence of operations and the determination of batch quantities and how they are to be dealt with enables the manufacturing cycle time to complete to be determined, and on this basis is quoted a commencing delivery date and rate of delivery, provided material is obtainable or available. Should material not be available then delivery date must be extended to suit its receipt. The manufacture of the product may, however, entail the making of special and complicated equipment, in which case the time to complete will, of necessity, be the predominating factor.

The steel people normally supply bar, tube and strip within certain specified lengths. For reasons that are obvious the short length cannot be eliminated, but full advantage should be taken of long lengths where possible, provided that handling is convenient.

The writer advises the tabulating of bar, tube or strip material to be dealt with as illustrated by Fig. 2 and the compilation of simple charts as illustrated at Fig. 3 for use by the estimator, progress and materials storekeeper.

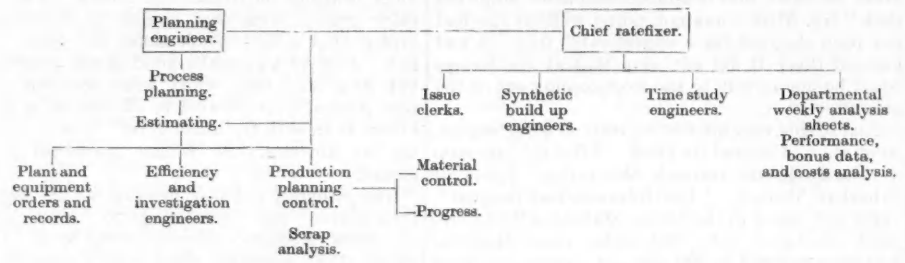


FIG. 1

Finish, Limits, Chamfers and Radii

To attain consistently and lay down definite standards for finish, as well as surface finish measurement, has been the object of much research and considerable investigation. So far no general agreement has been reached and as yet the first stages of standardisation have not been passed.

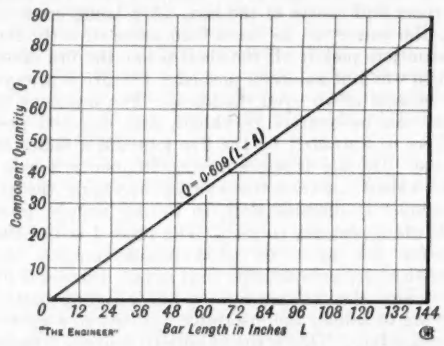


FIG. 3

The technique of super-finishing which originated in the Chrysler Corporation Works, U.S.A., and which has been further developed by the Foster Machine Company, also of U.S.A., has met with considerable success in Great Britain in conjunction with the profilometer, which measures the surface irregularities in micro-inches, *i.e.*, millionths of an inch.

The process of super-finishing has been fully and well described in the technical Press from time to time. It is sufficient, therefore, to say that the high metal ridges, irregularities or scratches of minute depth produced from the grinding wheel are further reduced, producing a refinement of finish previously unattainable by normal lapping, honing or grinding methods. Size is not appreciably affected.

While such finish is desirable for numerous mating parts for reasons that are obvious, it is of considerable importance to note and observe that the technician must be discreet in specifying a finish of this standard.

In grinding practice, finish and surface perfection depend upon a number of factors which have a bearing on chatter, flats, grit and traverse marks. Experience has shown that to attain good finish " time " is one of the most important factors, and since increased time goes hand in hand with increased cost the matter is worthy of more consideration than is at present given to it.

While it is all-important that comparison standards should be fixed for operators and inspectors' use (this is done in some concerns), the writer is aware that better finish is specified than is necessary in countless instances. The technician

Statement Showing Chucking and Parting-off Allowances, Together with Lengths of Material Required to Manufacture One Part and Test Pieces Required

Component.	Part No.	Material.		Section.	Machine type.	Stock dia.	Test piece.		Allowance.		Length.		Quantity per batch card.	
		Specification.	Description.				Length.	Quantity.	Chuck.	Parting off.	After first operation.	To make one.	Bars.	Parts.
Bush	1234	D.T.D. 155	Cold-drawn gun-metal	Herbert	4 B Herbert	1 $\frac{9}{16}$ in.	None	None	1·5in. min. 1·714in. actual	$\frac{1}{4}$in.	1·517in.	1·642in.	1	83
Pin	4321	S 82	Nickel-chrome case-hardening steel.	Single-spindle auto.	Steinle No. 36 Index auto.	1$\frac{1}{4}$in. ground	4$\frac{1}{2}$in. tensile 4$\frac{1}{2}$in. Izod	1 per bar	3in. min.	$\frac{1}{4}$in.	2·675in.	2·800in.	2	90
Roller	3214	3 S 15	3 per cent. nickel case-hardening steel	Ditto	Steinle No. 18 Index auto.	$\frac{1}{4}$in. black	4$\frac{1}{2}$in. tensile 4$\frac{1}{2}$in. Izod	1 per bar	2$\frac{1}{4}$in. min. 2·384in. actual	$\frac{5}{32}$in.	0·837in.	0·931in.	2	272
Nut	2143	3 S 11	55-ton nickel-chrome steel	Herbert	4 B Herbert	$\frac{3}{4}$in. ground	None	None	1$\frac{1}{4}$in. min. 1·556in. actual	$\frac{3}{32}$in.	0·349in.	0·443in.	1	308

Note.—Material to be ordered in 11ft. 6in. lengths to ensure minimum waste. This length is also suitable for handling in raw materials inspection, for crack detector, and for the machines upon which the parts are produced.

FIG. 2

must therefore ask himself if it is necessary to specify a finish :—

(1) Ground (specify grade),
(2) Polished,
(3) Honed,
(4) Lapped,
(5) Super-finish,

and, having decided, be able to justify the decision, bearing in mind that upon his decision rests an increase of approximately 3½ to 1 on a cost and time basis on rough and finish grinding, excluding cost of further refinements as per (3) to (5) above.

The same discretion can be applied to the fixing of limits, and it is gratifying to note that the Ministry of Supply has this already under consideration. Firms engaged upon work of national importance should at this time review the application of their work, and, if possible (it is possible in many instances), review the limits prescribed. By so doing equipment costs will be reduced, additional machine and man hours made available, resulting in increased output.

In the same category come chamfers and radii, the limits attached to many of these inviting criticism bordering on ridicule.

Such points as mentioned would be of appreciable advantage to already overburdened production departments, and the placing of the points mentioned in their right perspective would be no mean achievement.

The writer feels guilty of dismissing summarily, but nevertheless intentionally, matters which could be extended to form articles in themselves, and in defence would add that the abnormal and peculiar conditions existing in many concerns make significant the importance of instituting concentrated effort of reorganisation or refinements to existing procedure, which is equivalent to shrewd national industrial strategy. An appeal is made, therefore, to concerns large and small to make provision at this stage for the initiation, or overhaul of their control systems, such that accurate records are available and obtainable with the minimum of clerical work and to satisfy themselves of the co-ordination of departments directly affecting production functioning satisfactorily.

Permanent Magnets

By J. FERDINAND KAYSER, Assoc. Met.

DURING the early months of the 1914–1918 war British manufacturers seriously set to work to manufacture tungsten steel magnets. At first, numerous difficulties were encountered, but long before the end of that war they were able to produce magnets at least equal to any that had previously been produced elsewhere.

Since 1918 the magnet steel industry has undergone two revolutions. The first was brought about by the introduction of cobalt magnet steels, which were described in this journal by the present author in January, 1923. The second revolution was brought about by the advent of nickel-iron-aluminium permanent magnet alloys in 1933. These were revolutions in every sense of the word. Not only were the new magnets which heralded each revolution much superior to their predecessors, but they required different methods of manufacture and special technique to utilise their unique properties.

Tungsten steel magnets give a remanence in the vicinity of 10,000 and a coercive force of 65–70, with $(BH)_{max}$ between 250,000 and 300,000. The cobalt steel magnets give remanences varying from 8000–10,000 and coercive forces varying from 120 to as high as 250, combined with $(BH)_{max}$ varying from 500,000 to 1,000,000. The lower quality magnet steels contain, *inter alia*, approximately 9 per cent. of cobalt, whilst the higher grades, giving a $(BH)_{max}$ of 1,000,000, contain 35–36 per cent. of cobalt. On account of their high coercive forces, cobalt steel magnets are considerably shorter than tungsten steel magnets producing the same magneto-motive force. On the other hand, the cross section of a cobalt steel magnet must be slightly greater than that of the corresponding tungsten steel magnet. This fact has a very pronounced effect both on magnet design and on manufacture. Tungsten steel magnets, being in general long and slender, must be bent into the shape of a U. Cobalt steel magnets, on the other hand, are, comparatively speaking, short and thick and can frequently be accommodated in apparatus without being bent. The advent of cobalt magnet steel hence altered the design of instruments utilising them and at the same time altered the technique of permanent magnet manufacture.

Permanent magnets, owing their peculiar qualities to the presence, *inter alia*, of considerable quantities of nickel and aluminium, are characterised by comparatively low remanences, but by coercive forces of more than 500 and $(BH)_{max}$ in the vicinity of 1,500,000. The advent of this type of magnetic alloy brought about a further revolution in instrument design and a still greater revolution in permanent magnet production. In order economically to utilise these high coercivity magnets it was necessary to make them still shorter than heretofore.

The effect on permanent magnet manufacture was, however, much more profound. Tungsten steel magnets and cobalt steel magnets may be fabricated either from rolled bar or from castings. Both types may be softened readily and then be turned, milled, drilled, tapped, &c., without undue difficulty. The nickel-aluminium types of permanent alloys, on the other hand, cannot be rolled, forged or economically machined and can only be cast and ground.

The permanent magnet manufacturers are to be congratulated on so wholeheartedly having put into production these alloys. Less enlightened manufacturers would have endeavoured to boycott them in order to avoid rendering obsolete, expensive plant installed especially for the manufacture of cobalt steel magnets. That, however, was not the attitude taken by British magnet manufacturers, who, in a very short time after their advent in this country, were able to produce nickel-aluminium magnets better than any produced elsewhere.

A third revolution is now about to begin, due to the advent of permanent magnets with remanences in the vicinity of 12,000, coercive forces in the vicinity of 600 and $(BH)_{max}$ lying between 4,500,000 and 5,000,000. In view of the critical times through which we are passing, it is particularly fortunate that these improved permanent magnets can be manufactured without any serious change in manufacturing procedure. Briefly, it has been discovered that these improvements can be brought about by allowing certain alloys containing cobalt, nickel, aluminium and iron to cool from the high temperature heat treatment in a magnetic field of approximately 3000 C.G.S. units. This improvement was foreshadowed by certain work* of Oliver and Shedden, who found that by cooling nickel-aluminium-iron alloys of the Mishima type in a unidirectional magnetic field from 1200 deg. Cent. it was possible to bring about an increase in $(BH)_{max}$ of approximately 20 per cent. measured in the direction of the original field. At right angles to the field's direction the $(BH)_{max}$ was, on the other hand, approximately 10 per cent. lower than normal. These two investigators used a field strength of 4400 Oersted. The coercive force of the alloys was not influenced by the treatment to which they submitted them, and the improvement was mainly one of an increased remanence and $(BH)_{max}$.

A short while ago, British Patent Specification No. 522,731 was published, and for the first time the whole story of the new improvements was made available to the British public. Unfortunately, there is good reason to believe that some little time previously the facts were well known in enemy countries. The subject matter of British Patent No. 522,731 is based on communications received from Philips, of Eindhoven, Holland, who have found that treatment in a magnetic field yields unexpected results when applied to definite alloys. In particular it has been found that it is possible to secure an improvement in $(BH)_{max}$ of more than 50 per cent., thus attaining values between 4,000,000 and 5,000,000. According to the Philips' invention, the effect is obtained by applying the method in which a selected alloy is subjected to a magnetic field during the cooling operation. The results obtainable are well illustrated by Table No. 1, which is taken from the aforementioned recently published patent specification.

Results quoted in some patent specifications are frequently unduly optimistic. That, however, is not the case in so far as the present invention is concerned, and several investigators have confirmed the results, and permanent magnets are already available giving $(BH)_{max}$ well in the range claimed.

It is unfortunate that enemy countries are acquainted with this invention, but nevertheless its advent is welcome, as there is no doubt that British technicians will be able to make at least as good use of the new permanent magnets as will enemy technicians. Furthermore, the supply of cobalt, aluminium and nickel in Germany is far from satisfactory, whereas in this country, although economy is necessary, there is no real shortage of essential metals. The new alloys do not present any melting, casting or grinding difficulties, and it is only necessary to make provision to cool in a magnetic field. Price is, of course, always a consideration, but on the basis of the analysis the new improved magnets are likely to be economical substitutes for the nickel-iron-aluminium magnets heretofore used. The advent of this new steel will have a profound effect upon small apparatus which has heretofore been fitted with electro-magnets. Up to the present the very best magnet steels have not been able to compete with small electro-magnets, mainly because of their comparatively low remanence. The higher remanence (and $(BH)_{max}$) of the new magnets will, however, enable them to replace small electro-magnets and thus lead to an expansion of the demand for permanent magnets.

TABLE I

1.	2.					3.			4.			5.	6.
	Composition in per cent.					Optimum $(BH)_{max}$ obtained by making use of a usual thermal treatment (without a magnetic field) after ageing.			Results obtained by making use of a thermal treatment corresponding to that of the preceding column, but with the use of a magnetic field, after ageing.			Average cooling speed for gradual cooling in the region between about 1,200 deg. to 600 deg. Cent.	Improvement in $(BH)_{max}$ expressed in per cent.
	Ni.	Al.	Co.	Cu.	Ti.	$(BH)_{max}$.	Hc.	Br.	$(BH)_{max}$.	Hc.	Br.	Deg. Cent. per sec.	
1	16·0	8·5	23	—	—	1,220,000	348	9,050	3,450,000	492	12,650	1	183
2	13·5	8	24	1·5	—	1,320,000	370	9,450	3,770,000	505	13,100	2·6	188
3	13·5	8	24	3	—	1,680,000	535	8,300	4,780,000	600	13,350	1·8	185
4	16	7·8	25	—	2·8	1,600,000	604	7,600	3,057,000	640	10,000	4	91
5	14	7·1	24	3	2·4	1,720,000	595	7,900	3,780,000	660	11,050	4	110
6	14	7·5	20	6·5	1·8	1,650,000	620	7,350	3,250,000	676	9,825	4·3	97
7	16·5	8·1	20	1·1	2·3	1,824,000	640	8,150	3,117,000	685	10,200	4	71

NEW RUSSIAN COAL DEPOSITS.—The Soviet newspaper *Industria* reports that new coal deposits have been discovered near Leningrad. Hitherto the lignite deposits prospected in the districts of Selizharovo, Nelidovo, and Andreapol, had been estimated to contain reserves of 500 million tons, but as a result of new prospecting in the district of Valdai, the deposits are now estimated to contain 620 million tons. This year two mines will be put into operation by the Selizharovo Coal Trust (Selizharov-Ugol). In addition, a mine is being opened in Nelidovo, and another mine and quarry in Borovichi. These mines will produce hundreds of thousands of tons of coal a year.

PLATINUM IN AUSTRALIA.—News comes from Queensland of a complex platinum ore, associated with norite. The ore, although high grade and present in large quantity, has not hitherto been recognised as being of commercial importance. This is because of the unique nature of the combination in which the platinum group of metals occurs, viz., with thallium. Recent experimental investigations seem to indicate that the real difficulty in dealing with the ore can be overcome by preliminary treatment, which is simple when it is realised that the metals are present entirely in the form of stable complex compounds as an integral part of a homogenous basic igneous rock—a norite.

* *Nature*, 30th July, 1938, page 209.

Trends in American Electrical Development*

THIRTY years ago the average coal consumption required to produce a kilowatt hour of electricity was 5·4 lb. Twenty years ago it was 3·3 lb. To-day a modern base load station of 100,000 kW capacity can produce a kilowatt from 0·86 lb. of coal. Higher inlet pressures and temperatures and larger units or combination of units have contributed to this result. In the thirty years mentioned pressures have risen from 275 lb. to 1250 lb. per square inch, and there is now under construction in America a station that will work at 2400 lb. per square inch. During the time stated the inlet temperature has increased from 650 to 900 deg. Fah. Rapid strides have been witnessed in the increase and speed of turbine-driven machines. Research has made possible the building of larger 3600 r.p.m. machines than were available at 1800 r.p.m. in the year 1925. There is now under construction in America an 81,250-kVA, 3600 r.p.m. machine. This progress can be attributed to developments in metals as well as the improvement in efficiency and methods of dissipating losses; all triumphs of research.

In Fig. 1 is given the trend in the size of machines operated as units. An examination of

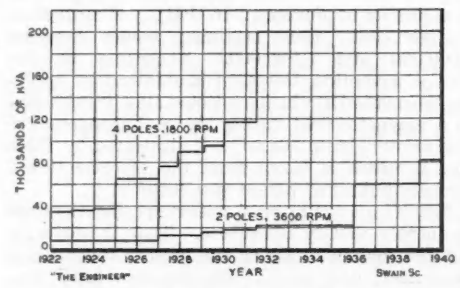


FIG. 1—TREND IN MAXIMUM SIZE OF 60 CYCLE TWO AND FOUR-POLE GENERATORS

the ratings of machines purchased in the last five years indicates a trend towards smaller and higher speed units placed closer to load centres. Some of the trend towards smaller generators may be attributed to the fact that many of them are superimposed machines. Actually, however, the combination of the superimposed and low-pressure units sometimes results in a fairly large unit. The trend towards the use of hydrogen-cooled generators has been very pronounced for the larger high-speed units. Hydrogen is a very efficient heat conductor and is lighter than air. Hence the windage losses, which are large in 3600 r.p.m. machines, are materially reduced. By the use of hydrogen the building of large generators with an efficiency approaching 99 per cent. has been made possible. In the last five years 95 per cent. of the units for which hydrogen is economically suited have been cooled in this way.

The question of appearance has received the undivided attention of the manufacturer and user alike. To improve the appearance of units and to blend their different parts into a pleasing assembly preliminary artists' drawings are prepared for the larger machines, before work is started on the final designs. Corners are rounded, unsightly pipes, valves and other parts are concealed and the whole is finished to present a good appearance. The first designs of hydrogen-cooled machines had the water box of the cooler and water piping exposed, but now these are completely enclosed with a housing, which blends the lines of the main machine. A direct-connected exciter is built in an enclosure. The smaller machines are also built to present a good appearance and to make stations present a good aspect as a whole.

Although improvement in efficiency of steam generation has restricted the field of economical water power developments, there is still a demand for even larger water wheel generating units. In Fig. 2 is shown the trend in size of water wheel-driven machines. The 108,000-kW Grand Coulee machines are the largest in size and rating yet undertaken.

A concentrated effort has been made to obtain a clearer and better understanding concerning the fundamentals of power transmission. Following the World War, increased loads necessitated working existing lines to the limit. Some of them failed under the strain and consideration was given to methods of overcoming the difficulties. Stability of systems became a much-discussed problem, and methods were presented for calculating the performance of lines. Although the analytical methods of calculating the performance of systems were well understood, the problem is very tedious and sometimes impossible of solution, especially with the more complicated systems having many generating stations. As a result of these difficulties the A.C. network calculator was devised as a means of setting up systems in miniature, placing different types of faults on the system and allowing a recording of the results of various switching operations. In other words, the system is set up in miniature and operated as the actual system would be in practice, with the advantage that faults can be applied and switches can be opened and closed at will without jeopardising the service, such as would be the case if tests were run on the actual system. The network analyser has been in operation for ten years, and more than 200 systems have been studied for practically all the ailments that

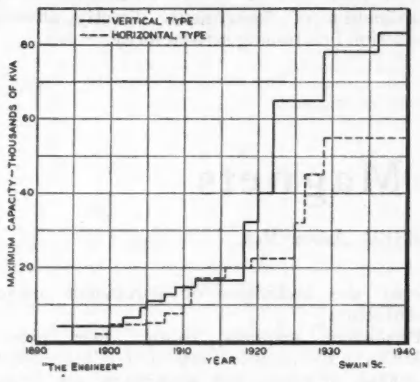


FIG. 2—TREND IN MAXIMUM WATER-WHEEL GENERATOR RATINGS

could possibly exist in an electrical system. During the past ten years the utility of the calculator has been broadened and it has been used for new and interesting problems.

The De-ion protector tube is a device that is placed in parallel with the line insulation. When lightning strikes the line, the surge current flows through the tube instead of the insulator. At the time of breakdown the tube is virtually a short circuit on the line. To operate properly it must become an insulator before the oil circuit breakers controlling the line are tripped out. It is known that arcs in contact with certain materials cause them to produce de-ionising gases, which try to extinguish or de-ionise the arc at or close to the current zero. It is also known that when a short circuit is applied to a system and is removed the system voltage drops to a low value and then recovers at a rate depending on the system line characteristics, transformer loads and other factors. Whether the arc will extinguish or not depends on the rate at which the system recovery voltage tends to maintain the arc path in contrast to the rate at which the de-ionising action tends to build up dielectric strength. If the dielectric strength recovers faster, then the arc is extinguished; if the system voltage recovers faster then the tube re-strikes. Hence there is a race between these two opposing factors and the problem is to predict the results before actually running the race. Laboratory tests will give the dielectric recovery of tubes, but it is difficult to take a system and test it for all possible

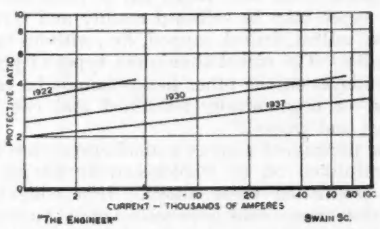


FIG. 3—IMPROVEMENT IN LIGHTNING ARRESTER PROTECTION

variables to obtain a true picture of the system recovery voltage or the other factor in the race. Here again the network calculator has made possible a solution of the problem that had not hitherto been undertaken in a broad way. The satisfactory application of the De-ion protector tube has enabled lines to be designed that are practically lightning-proof and has provided a means of rehabilitating lines already constructed, but vulnerable to lightning troubles.

As a result of the investigations on lightning, in which the instrument known as the Fulchronograph has played a prominent part, economical high-voltage lightning-proof lines can be built by the proper use of earth wires. Lines in lower-voltage classes already built or being built can be made practically lightning-proof by the application of the De-ion protector tube. The findings resulting from the investigations have influenced lightning arrester design, and Fig. 3 shows how the protection ratio of lightning arresters has been lowered. Recognising the possibility of having to discharge currents of high magnitude, the arresters have been made capable of carrying these currents, whilst giving protection to the apparatus. Moreover, the characteristics of arresters of the line type have been changed to be capable of discharging surges of long duration.

High-speed reclosing circuit breakers with times selected to ensure maintenance of synchronism of the equipment have been put into use in high-voltage sub-stations. Breakers for 132 kV are now available that can re-close a line in less than twenty cycles from the inception of a fault. The limit to which this speed can be carried is dictated by the open time to allow the arc path of the fault to de-ionise. On 132-kV systems this is in the neighbourhood of 10 to 12 cycles. This time plus the opening time of the breaker still allows the re-closing when the operation is on a tie between two large systems. Re-closing would not be feasible when all the power is transmitted, as times shorter than this de-ionising time must be secured to maintain synchronism.

Quick clearing of faults on all systems is desirable, and improvements have resulted in clearing times in the neighbourhood of eight cycles. To utilise the improvement in breaker speeds high-speed relays have become standard equipment on important lines. Relays are now available that will operate in less than one cycle for faults occurring on the greater part of a line section. The great concentration of power in the United States during the last ten or fifteen years severely taxed the switchgear available and an intensive study of switchgear design and operation became necessary. The introduction of the De-ion circuit breaker some ten years ago was the first step towards improvement. To-day, a 100,000-kW station can be built with dry type breakers throughout. A recent addition to the circuit breakers is the compressed air breaker in which compressed air operates

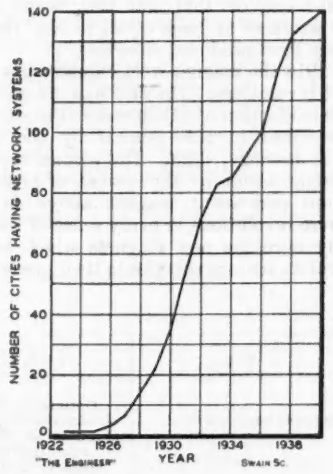


FIG. 4—TREND IN THE USE OF THE A.C. SECONDARY NETWORK SYSTEM

the opening and closing mechanism and compressed air blasts give aid in extinguishing the arcs. Approximately 2000 interrupting tests have been made on a 1,500,000-kVA breaker of this type. Single-phase interruptions have been made of currents from ¼ ampere to 65,300 amperes with 13·2 kV across the contacts. Throughout the current range cathode and magnetic oscillograms were obtained. All currents can be interrupted at the first zero with about one half-cycle of arcing. Low-current interruptions do not give rise to large over-voltages and throughout the range of tests no transient voltage greater than twice normal was observed. Moreover, the high currents can be interrupted without external flame and without objectionable noise. The idea of factory-built and assembled switchgear has been developed to a point where a complete sub-station of 1000 to 2500 kVA is now enclosed in a common tank.

As regards fundamental transformer design, tests made with surge generators have shown how to increase the impulse strength by 50 per cent. by better arrangement of the insulating structures. Recently it has been found that this strength can be increased by 30 per cent. more by vacuum in the transformer. This eliminates all the gases in the windings and therefore raises the point at which corona begins to form, which is the starting signal in the failure of an insulating structure in this type of equipment. It has been found, moreover, that if oxygen be eliminated from the transformer greater short-time loads can be carried with the same margin of safety. As a result of these findings transformers are now being run under vacuum and others are simply sealed so that no air can enter. The former principle is used on large high-voltage transformers and the latter on transformers of 1000 kVA and less. The development of a relay to permit the loading of transformers by copper temperature allows transformer users to take full advantage of these schemes.

One of the outstanding trends in the field of distri-

* Abstract of a paper on "Trends in Electrical Apparatus Development," read by Mr. A. C. Monteith, before the American Institute of Electrical Engineers.

bution has been the increasing use of static condensers for power factor correction. As the result of low initial cost they are justified on the basis of increasing the system capacity, resulting in an overall saving in the total system investment, particularly on systems operating with low power factors. The use of the low-voltage A.C. secondary network system continues for concentrated load areas and where reliable service is required, and Fig. 4 shows the growth of this scheme. The desire to eliminate oil in the vaults of buildings or congested areas has led to the use of non-inflammable liquid in place of oil. The Westinghouse Company has built over 1000 of these transformers for use in industrial works or central stations where oil involves fire risk.

As regards the future, although the largest 3600 r.p.m. generating set under construction is an 81,250-kVA unit, designers would not hesitate to build a 100,000-kVA unit running at this speed. Water-wheel driven generators are now only limited by manufacturing facilities and the industry is now ready to build any size machine within those limits. Although there has been no demand for higher transmission voltages than those already employed, the electrical industry could produce 330-kV apparatus with present design knowledge. All high-voltage lines now being built will be of the lightning-proof design, and it is expected that means will be found to make the low-voltage lines lightning-proof at reasonable cost. The quick clearing of faults will no doubt be studied with a view to improvement, although with a decrease from 25 to 8 cycles, already accomplished with modern interrupting devices, further improvement will no doubt be made at a slower rate.

On account of the improvement in the efficiency of smaller generating units, the trend in future will no doubt be to place smaller steam stations close to load centres, thus minimising transmission costs and losses at the expense of a slight increase in operating charges. These stations will have dry breakers throughout and oilless indoor transformers for the auxiliary supply. In the distribution field the demand for better service will be met by new and improved methods. A larger number of supply companies are to be found using the low-voltage A.C. network for the heavier load densities, and a number are trying different schemes for the lighter density areas.

South African Engineering Notes

(By our South African Correspondent)

Base Minerals Inquiry

THE Committee of Inquiry which has examined over a period of two years into conditions in the Union's base metal industry has submitted its report, and this has just been published, after some delay. This delay has, however, impaired neither the interest nor the value of the report, which may have an important effect on the whole future of the Union's base mineral mines. The important place which base mineral products have already taken in the Union's national economy is shown by the following figures for local and overseas sales in 1938 :—Coal, £1,486,000 ; manganese, £561,000 ; chrome ore, £240,000 ; tungsten, £17,000 ; copper, £471,000 ; tin, £98,000 ; asbestos, £424,000 ; limestone products, £720,000. The total value of these products was a little more than £4,000,000, and they do not include the 1,290,000 gallons of oil produced from South African torbanite during approximately the same period, and the lesser values of gypsum, sulphur, mineral pigments, fluorspar, corundum, magnesite, natural gas, mica, silica, graphite, Kaolin, barytes, and garnets.

The development of these valuable deposits of base minerals, which are capable of much more profitable exploitation, has hitherto been almost as haphazard as their geological occurrence. The Committee recommends that a Mineral Development Section of the Department of Mines be formed, which will be in charge of a senior technical officer (acting for the Government Mining Engineer), to promote control and co-ordinate efforts to stimulate the exploitation of the Union's base minerals ; that the Union Geological Survey should be brought under the control of the engineering branch of the Department of Mines ; and that the Fuel Research Board should also be taken over by the Department of Mines. The Committee recommends further that certain obstacles to prospecting be removed ; that the Government should have a greater part in negotiations with the railways for freight concessions to base metal industries ; and that generous tax concessions should be given by the Treasury to developing and adolescent base metal companies. It further recommends that where prospecting, although manifestly in the national interest, does not present sufficient inducement to private people, it should be undertaken by the State. It is also recommended that the present aerial photographic survey should be extended as far and as rapidly as possible. A suitable research laboratory to investigate the more economical production of the base minerals and their processing for local manufacture is also urged.

Rhodesia Broken Hill

The mining operations of the Rhodesia Broken Hill Development Company, Ltd., during 1939 resulted in the production of 12,695 long tons of zinc and 736 long tons of fused vanadium oxide, compared with 10,215 and 717 long tons respectively the year before. Metal sales realised £557,129, against £489,845, and the profit before providing for taxation was £207,750, which is £42,275 more than that earned in 1938.

The consulting engineer reports that, in view of the satisfactory reserves of oxide ore disclosed by diamond drilling, and particularly the high-vanadium content, it was decided to make certain additions to the plant. These additions will enable the plant to produce 20,000 tons of zinc a year, at the same time maintaining the output of vanadium at 720 tons a year. By this means, the engineer states, the revenue from zinc should be increased considerably and the cost of production should be reduced by some £2 to £3 a ton. The tonnage mined during the year was estimated at 73,980 short tons of zinc ore and 42,840 short tons of vanadium ore. In addition, 17,675 short tons of zinc and vanadium mixed ore were produced. Dr. Bancroft submitted at the annual meeting of the company a report showing the following increases in the visible ore reserves :—

	1938.	1939.
Oxide ore, tons	2,209,000	2,400,000
Zinc, per cent.	23	23·5
Lead, per cent.	7	6·7
Vanadium, per cent....	1	0·83
Sulphide ore, tons ...	1,200,000	1,600,000
Zinc, per cent.	35·5	36·7
Lead, per cent.	23·5	23·9
Sulphur, per cent. ...	17·5	18·2

The chairman said at the annual meeting that the company hoped to complete the plant extensions with the funds accruing from current profit. The acid and leading plants and the vanadium flotation plant should be completed by March or April, 1941, and the Lunsemfira power scheme by the end of that year. The question of the sulphide ores is under consideration.

Promoting Industries

The expansion of South African industries is now receiving the constant and unflagging attention of the Department of Industries. It has recently appointed a large number of experts to investigate the production of requirements of the Union during the war, including glycerine, power alcohol and wooden boxes. It is also going into the question of increasing the production of fertilisers so that the agricultural output shall not be decreased owing to the loss of supplies from countries such as Holland. In addition, the production of all war materials is going ahead very rapidly, and in a short time the Union will be in a position to look after itself and probably aid other parts of the Empire not so fortunately placed as regards heavy industries as is the Union.

Cape Town's New Harbours

The original contract for the part construction of Cape Town's new harbour and the reclamation of the foreshores is due to be completed in a year's time—July, 1941. The Dutch contractors, however, have been authorised to undertake additional work, including the filling in of an area of sea in the vicinity of the new graving dock (to be constructed) and round the yacht harbour. The work already done has revealed that the original estimate of the quantities of material necessary for the reclamation of the foreshore will be exceeded before the job is completed. It is possible, therefore, that the harbour and foreshore scheme as far as at present authorised will not be entirely complete before the latter end of next year.

The immediate task of the Harbours Administration in the harbour scheme (outside the work contracted for by the Dutch company) is to complete the new quay wall for a distance of 4000ft. from the South Arm towards a point beyond the line of the extended Adderley Street of the future. The foundations of this quay wall are now crossing the line of the random block mole, which means that little more than one-half of the quay wall has been completed.

As this work proceeds greater depths of water and sand are being encountered before rock is found upon which the foundations of the quay wall must rest. This may slow down progress, and it is expected that at least another year will be required to complete this quay wall. Thereafter there will remain some 6000ft. of quay wall—2000ft. along the shore side of the harbour and 4000ft. along the outer mole—to be constructed before the harbour scheme will be constructed and completed in its entirety.

With regard to the new graving dock, the first essential step is to convert the site—at present water—into dry land. This has been authorised and is now being done. In due course barriers of steel sheet piling will be erected round the site of the dock to keep back the sea, after which the huge excavation necessary to construct the dock will be begun. The whole site has been surveyed and it is understood that preliminary drawings of the dry dock are now being prepared.

Dredging and reclamation work is making good progress ; a further 238,000 cubic yards of material were removed last month and deposited on the area to be reclaimed. Altogether 7,780,900 cubic yards of material, representing over 70 per cent. of the dredging to be carried out by the Dutch contractors, have now been removed. The removal of the old random block mole is now nearing completion. Approximately 31,000 blocks have been dealt with. The extension of the new quay wall, containing "E," "F" and "G" berths, has been completed over a distance of 2054ft.

Union Railways' Record Truckload

Recently the South African Railways dealt with the largest and heaviest concentrated load they have yet carried for any considerable distance. The Administration has acquired various types of special high-capacity wagons to deal with unusually heavy loads and with loads which are so large as to be out of gauge. The largest of these is the type U8 "Super" well wagon, which is designed to carry a normal maximum distributed load of 76 tons. There are four of these in service, and each is mounted on two special six-wheeled high-capacity "buckeye" bogies so as to keep the axle load within permissible limits. One of the wagons, No. 23, only recently acquired, was specially selected and strengthened to carry the record load of nearly 83 tons, which consisted of a turbo-alternator stator, landed at Lourenço Marques, and which had to be transported from there to Orlando power station, Johannesburg, where it has been installed to provide a much-needed increase of the power supply.

This machine is among the largest of the stators yet imported into this country and generates 37,500 kW at 3000 r.p.m. It was built by the General Electric Company of England at a cost of about £20,000, and some idea of the size can be gathered when its dimensions are stated :—Length, 16ft. 8in. (actual base 11 ft.) ; width, 10ft. 9in.; and height, 10ft. 7in. When loaded on the well wagon the top was 13ft. 3in. from rail level, which is 3in. above the standard loading gauge, and the width exceeded the gauge on either side by 4½in. The weight (with packing) of nearly 83 tons was exceptional, for not only did it exceed by 7 tons the normal maximum carrying capacity of the wagon, but the load was concentrated over the central 11ft. of the well instead of being distributed over the whole 20ft. Allowing for this concentration of weight, the stator really represented an overload of 20 per cent. (or 15 tons) and was equivalent to a distributed load of 91 tons, which is just within the maximum permissible for the type U 8 well wagon, when special arrangements are made for transit and packing. Because of its abnormal size and weight the load was hauled under special conditions all the way from Lourenço Marques to Johannesburg. The train was confined to daylight running only and was subject to a speed restriction of 20 m.p.h. throughout, the load being conveyed as near to the engine as possible.

Research Committee Set Up

It is officially announced that arrangements are being made to establish immediately small technical committees for fuel substitutes research and munitions research within the Union of South Africa and also that, where possible, the committees are to be formed on an interterritorial basis. It is hoped that a joint body representative of all the Governor's Conference territories may be established soon to deal with economic and industrial questions. If this proves possible the proposed new committee will work under that body.

In the matter of fuel research it is known that one sugar factory in Uganda is able to manufacture annually 200,000 gallons of good alcohol and experiments by the Uganda Government have proved that cotton seed oil is a good diesel engine fuel. As regards munitions and military equipment, much has been done already, but so far no technical committee has been charged with the duty of examining the whole field of military requirements to see if more can be accomplished.

OVERLOADING THE RAILS.—The September *Bulletin* of the British Road Federation, Ltd., has a note protesting against the policy of switching an immense volume of traffic from the roads to the railway companies, which has resulted in seriously over-using one form of transport, while another, more mobile, more flexible, and more economical, is not being fully utilised. The writer argues also that there is an appreciable increase in the delays and the cost of handling the flow of foodstuffs, raw materials, finished goods and munitions coming into the country and the equally important flow of exports necessary to pay for them. The Minister of Supply, in the House of Commons, admitted that he had had letters claiming that the production of munitions was being hampered and made more costly to the nation by the Government's insistence on their transport by rail, but replied that the rationing of liquid fuel had necessarily resulted in a certain amount of traffic, including munitions traffic, going by rail which might otherwise have gone by road. He was satisfied that this had not substantially hampered the production of munitions.

The Engineer

SEPTEMBER 20, 1940

VOL. CLXX No. 4419

Contents

THE ENGINEER, September 20th, 1940. PAGE

A SEVEN-DAY JOURNAL ... 179

LEADING ARTICLES—
BOONDOGGLING ... 186
THE WEAR OF LUBRICATED SURFACES ... 186

SPECIAL ARTICLES—
FURTHER NORTH AMERICAN LOCOMOTIVE EXPERIENCES No. I. (Illus.) ... 180
PERMANENT MAGNETS ... 183
SOME FACTORS AFFECTING ECONOMIC PRODUCTION ... 181
UNITED STATES LINER "AMERICA." No. IV. (Illus.) ... 189

MAGNETIC CRACK DETECTION. (Illus.) ... 191
PACKING MATERIAL SUBSTITUTES IN GERMANY ... 192
PHOTO-ELECTRIC METER TESTING. (Illus.) ... 190
TRENDS IN AMERICAN ELECTRICAL DEVELOPMENT. (Illus.) 184

LETTERS TO THE EDITOR—
CONCRETE FOR MACHINE TOOLS ... 187

LITERATURE ... 187

NEWS AND NOTES—
MARKETS, NOTES AND NEWS ... 193
NOTES AND MEMORANDA ... 194
SIXTY YEARS AGO ... 193
SOUTH AFRICAN ENGINEERING NOTES ... 185
TECHNICAL REPORTS ... 193

NOTICES TO READERS

PAPER SUPPLIES

With a view to the conservation of paper, readers are advised, in the interests of all concerned, to place a regular order for THE ENGINEER with their newsagent or direct with the Publisher.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

*** *For Subscription rates, see page 2 of Advertisements.*

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGES OF ADDRESS

*** *Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses**, *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Postal Address: "The Engineer," 28, Essex Street, Strand, London, W.C.2.

Telegraphic Address: "Engineer Newspaper, Estrand, London." Telephone: GERrard 8565 (10 lines).

BOONDOGGLING

OUR literary education has been neglected; in America our name would be mud. We do not know what boondoggling means. Every schoolboy in the land of freedom—of speech—knows, and we do not. We have read a whole article in *Iron Age* entitled "Boondoggling in Defense," and yet we do not know. We have tried a famous American dictionary, but it does not help. It tells us that a boon is a gift, which we knew; but it is silent about doggling. Yet, ye merciful powers, what a word! How it fills the tongue and rolls in the vault of the mouth. What possibilities it has; what thoughts does it startle into life. It is all very well for Stevenson to tell us that "Language is but a poor bull's-eye lantern, wherewith to show off the vast cathedral of the world." Given a handful of words like this, we would defy him. We can do what we will with it. Like Humpty Dumpty, we can make it mean what we want it to mean. It shall stand for asking a loan, courting by moonlight, dodging the bailiffs, writing *vers libres*, painting like Van Gogh, carving like Epstein, or making public speeches when the purple bubbles have winked liberally at the brim. All these things we might make it mean, and many more. Yet we have a suspicion that it is not any of these; that it has some quite commonplace, pedestrian significance to all who are happy to be born Americans.

Indeed, after mature study we have come to the conclusion that boondoggling stands for "not-planning in advance," the capital crime in the United States. Hence it has a kinship with "muddling through." We have so decided because the article in *Iron Age*, by Colonel H. A. Toulmin, jun., expounds and castigates the defects of military officers and industrialists to tackle the problems necessary for adequate air protection in America. To all who have felt humbled by the ability of our cousin to plan it will come as refreshment. If America can do no better than this then we after all are not so bad; it is even possible that we, since the war began, have done more to solve familiar problems than the Americans have done. We are flattered by the thought that we, their disciples, may be able to give them a lesson or two. For one thing, the traditional conflict between civil and military experts is hampering our efforts less than of yore. It will never be got rid of, but we believe Mr. Morrison has already achieved something and will achieve more, whilst Lord Beaverbrook, with a strong infusion of civilian engineers in his Council, is making good progress. His problem is perhaps easier. The R.A.F. is young, flexible and more amenable to new ideas than the Army. It is of especial interest to observe that Colonel Toulmin attacks the same points that Lord Beaverbrook has been attacking and which we ourselves have taken as our theme. He is more precise than anyone here has publicly ventured to be, and it is worth quoting his words at some length. "The truth of the matter," he says, "is that for many years the Army Air Corps has been more interested in engineering types and changes, the constant change of absurd manufacturing tolerances, and the maintenance of speed records and other sporting events rather than in doing the hard, tough, prosaic work of building combat ships of heavy striking power that can get military results. This same management can overnight reduce the cost of aircraft not less than 30 per cent. and can double the production of aircraft with present facilities by a 10 to 15 per cent. reduction in manufacturing tolerances. Aircraft is now being built on the basis of an automobile to last four or five years. Every intelligent soldier of the slightest experience with Air Corps work knows that most ships last no longer than the average pilot's life. Most European nations of experience figure that thirty to fifty hours in the air is all that a ship may do or will be permitted to do. Therefore, there is no point in the most meticulous refinement and accuracy with absurd tolerances for the most elaborate manufacture. Most of this comes from the effort of the Army to make the results of its appropriations last as long as possible in peace time. Producing for war fighting ships is quite another matter. If the Air Corps command had been on its toes it could have remedied the situation. It is the old story of the Army requiring absurd specifications which hamper the production of munitions and which makes them so dreadfully expensive and intolerably slow in production. Then the Army blames the manufacturers. Here is where a forceful and well-informed Secretary for Air, with a good staff, can put practical tolerances into the air programme."

Whilst there can be little doubt that Colonel Toulmin's precise figures will be challenged, the principle which lies behind them will remain sound and untouched. The expectation of life of fighting aeroplanes may be more than thirty to fifty hours in the air. The R.A.F. must by now have returns from which an actuary would have no difficulty in deducing a reliable figure. That figure should be taken as the basis and if any part of an aeroplane has an expectation of life more than, let us say, three times the basis, then it should be scrutinised with extreme care. There are, of course, parts of every machine which must have unlimited life. From their nature they are not subject to wear or to serious stresses. Manifestly nothing can be done with them. But there are others of a different kind which wear out at a fairly determinate rate, and it is with them that something may be done. There are yet others which are protected against rust or made of rustless materials. For a long life that may be very desirable; for a short one it may be too costly in time, money and materials. We believe that Lord Beaverbrook and his technical advisers are looking anxiously into all such problems as these and accelerating the output of aeroplanes by solving them. The country cannot afford to make things too good for their purpose, as it has done in the past. Niceties of finish, finicking dimensions, expensive materials and methods, must be given up, whatever the heartburnings, if they cannot be proved to be essential to the proper development of the functions of the machine during its probable life—a reasonable factor of uncertainty being allowed.

The Wear of Lubricated Surfaces

IN a paper published in the *Journal* of the Royal Technical College, Glasgow, which we propose to reprint in a later issue, Dr. A. S. T. Thomson and Mr. R. Logan record some interesting results of experiments designed to investigate the amount of wear suffered by lubricated metal surfaces. The experiments were of a strictly limited character, being confined to one pair of metals—brass running against steel—and three lubricants—standard mineral oil, standard mineral oil plus 0·5 per cent. of oleic acid, and standard mineral oil plus 1·0 per cent. of colloidal graphite. The recorded results relate to the wear of the brass, which was in the form of a pin bearing against a rotating steel wheel. No measurable wear was noted on the steel wheel. The precise figure measured was the rate of wear of the brass in cubic inches per minute under various pressures between the pin and the wheel. The nature of the results obtained may be indicated by summarising those recorded when the lubricant was standard mineral oil without any addition. It was found that up to a pressure of about 1650 lb. per square inch the rate of wear was constant at any particular pressure and increased more or less in accordance with a straight line law as the pressure was increased. With a new brass pin a test was then made under a load of 2400 lb. per square inch. The rate of wear was found to be *less*, indeed much *less*, than what it was with a load of 1650 lb. It amounted, in fact, to little more than one-twentieth. This same low rate of wear remained practically constant at all loadings up to about 3000 lb. per square inch. Thereafter as the loading was increased the rate of wear started to rise again rapidly, following a straight line law substantially parallel with the earlier line. Further, it was found that once a pin had been run under a load lying between the lower and upper "critical pressures" of 1650 lb. and 3000 lb. respectively, the same low rate of wear persisted, when the load was reduced below the lower critical pressure or increased above the upper critical pressure. The same general characteristics were observed with the two other named lubricants, the main difference being a widening of the range between the critical pressures.

The phenomenon described by Dr. Thomson and Mr. Logan is of considerable scientific interest and probably of no little practical importance. Before, however, we can draw any general conclusion from it, it would be essential to have the experiments repeated with a range of different metals. Its explanation is not very obvious. Naturally, the first one that comes to mind is that the reduction of the rate of wear when the lower critical pressure is exceeded is a result of work hardening. Against this supposition we have the fact that numerous tests with the Rockwell and the Herbert pendulum hardness testers failed to reveal any appreciable difference in the hardness of the brass after it had been subjected to loads above the lower critical pressure. Even if this positive evidence against it were not available, the supposition that work hardening is the explanation of the phenomenon would hardly serve unless we add to it a "work softening" characteristic to account for the renewal of increasing rate of wear above the upper critical pressure. The authors' tentative explanation of the phenomenon is that during the first phase up to the lower critical pressure the wear which occurs is in the nature of pure abrasion, the asperities of the one surface cutting off the asperi-

ties of the other. Following the views advanced by Dr. Bowden, they believe that during this stage temperatures would be reached at highly localised points sufficient to melt the brass and to result in the contacting surfaces being wiped and smoothed. The smoothness of the surfaces would then permit the formation of a viscous oil film between them, which would considerably reduce the wear. Later on, when the load reached a certain value—the upper critical pressure—the oil film would be ruptured and under the metal-to-metal contact the rate of wear would resume its rising characteristic. Support for this view is provided by the fact that when the temperature of the oil bath in which the brass pin and steel wheel rotated was lowered the upper critical pressure rose, a fact which is in accordance with the established theory of oil films. This explanation commands our respect, but there is at least one other which may be equally probable. It is possible that under the high loadings employed and the resultant high localised temperatures generated the brass passes from one metallurgical phase, which is not highly resistant to wear, to a second which is much more resistant and finally to a third of renewed decreased resistance. The fact that no appreciable difference in the surface hardness of the brass was noted after it had been run at loads lying between the critical pressure would not negative this supposition, because it has been well established that hardness and resistance to wear in a metal are not necessarily synonymous.

From the practical point of view the results recorded by Dr. Thomson and Mr. Logan seem to suggest that the somewhat tedious process of "running in" a machine or engine might be considerably shortened if the bearings and shafts before assembly were run together under a load lying between the "critical limits" and considerably in excess of their normal loading. It appears that the length of time during which they would have to be in running contact would be quite short, a matter, indeed, merely of minutes. In these few minutes, it would seem, the same result would be obtained under the high loading as is realised during the careful nursing of, say, a new motor-car during its first five hundred miles. Before, however, we theorise further on the subject or attempt to draw additional possible applications in practice for the phenomenon, we ought to know much more about it. It would be of value if the experiments were repeated with other pairs of metals. It would also be useful to learn whether the low rate of wear between the critical loads is purely a surface phenomenon or whether a specimen which had been brought into the low rate of wear phase would continue to exhibit the same low rate of wear after a small amount of material had been cut or otherwise removed from its bearing surface.

ANOTHER ALLOY FOR INDUSTRY.—An American company claims to have perfected a new light-weight, high-strength, rustproof alloy, which has good forming and drawing qualities and lends itself to gas, spot, seam, and arc welding, brazing, soldering, and reaction soldering. The metal has an ultimate tensile strength of about 32 tons per square inch, and polishes to a silvery chromium-like appearance. It is non-magnetic and non-sparking.

Literature

Properties of Ordinary Water Substance. Compiled by N. ERNEST DORSEY. Reinhold Publishing Corporation, New York. 1940. Price 90s.

BY arrangement with the Inter-Allied Conference of Pure and Applied Chemistry, which met in London and Brussels in 1919, the American Chemical Society was to undertake the production and publication of scientific and technical monographs on chemical subjects. This remarkable book is one of those monographs. It deals with water substance, "In all its Phases: Water Vapour, Water, and all the Ices," as the sub-title of the work defines its scope. The compilation was begun under the auspices of a committee of the National Bureau of Standards, of which the late Mr. E. W. Washburn was Chairman, and its purpose, as defined in the preface, "is to present, either specifically or by reference, all the material likely to be of interest to anyone studying the properties of ordinary water substance, *i.e.*, that of the usual isotopic composition." The book forms a veritable encyclopædia of all knowledge relating to water substance. It contains innumerable tables and many graphs, and is particularly richly documented. The "International Critical Tables" has, as far as possible, been depended upon for information available before January 1st, 1923, and the compiler himself searched the journals for the period 1922 to 1938. It is a remarkable fact, considering the scope of the work, that he can express a hope that no important article published before 1938 has been overlooked.

The main headings under which the material is arranged are:—Synthesis, Dissociation, Water Vapour, Water, Ice, Multi-phase Systems, Phase Transition, Miscellanea. But that list gives but a faint idea of the scope. The following are a very few of the sub-headings:—Inter-action of Water Vapour and Corpuscular Radiation, Acoustic Data for Water Vapour, Luminescence of Water Vapour, Spectra of Water Vapour, Rigidity of Water, Pressure-Volume-Temperature Associations for Water, Emissivity of Water, Deformability of Snow, Dielectric Properties of Ice, Solubility of Selected Gases in Water, Fugacity and Activity of Water.

Engineers are, in general, concerned only with a relatively few properties of water substance. The steam engineer wants to know the relations between pressure, volume, temperature, entropy, &c., and the civil engineer is concerned with those factors which are found discussed in books on "Hydraulics." These subjects form relatively small sections of this book, and they are dealt with in a manner that does not facilitate the work of the engineer. The appeal of the work is, in fact, principally directed towards chemists and physicists, for whom, in fact, it is principally intended. The development of knowledge has been so rapid during the last fifty years that it is difficult for any individual to keep in touch with branches of science outside his specialty. It is not the expert on "water substance," but he who is not especially well acquainted with the field concerned who has been principally considered in this compilation. It is hoped by the compiler that the book will help chemists and physicists to realise how closely their investigations may be connected with other work which on the surface appears far afield from their own, and that it will promote research by furnishing a survey of the progress already made.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

CONCRETE FOR MACHINE TOOLS

SIR,—I read your Leader, "Concrete for Cast Iron," in your issue of August 30th last with considerable interest, and feel that you might like to have particulars of how I used a composite, iron and concrete, construction for a machine tool that I found I needed in a hurry.

The position was that my firm was entrusted with an urgent and important Government contract for a certain article that was entirely different from our normal output.

In the manufacture of this article there was one job consisting of the facing of the sides of a large casting, some 4ft. 6in. by 18in. by 23in.

The only machines we had suitable for this job were planing machines, and if the job were put on these, and considering that the contract was a long-term one, the result would have been the complete disorganisation of the shop's normal output.

As the other operations could be managed without upsetting normal output, it was decided to procure a machine for carrying out this operation.

As this machine would only be required for the one job, it seemed waste of money to put down a normal and universal machine, and, moreover, the cost of a machine of that size would have been greater than the job warranted, even if a reasonable delivery could have been obtained.

Under these circumstances I decided to build a machine, and in order to reduce the cost and to speed up its production to use concrete to a large extent in its design.

The table and ways were made in cast iron, as also was a light "skeleton form" for the frame. These castings were of a very simple nature, and were only machined where necessary.

They were then assembled on site, bolted, and spot welded together in their relative positions, gauges being made so as to watch the alignment during the setting of the concrete.

Shuttering was then put round the whole, and after suitable reinforcing bars had been put in, the whole was filled in with a quick-setting concrete.

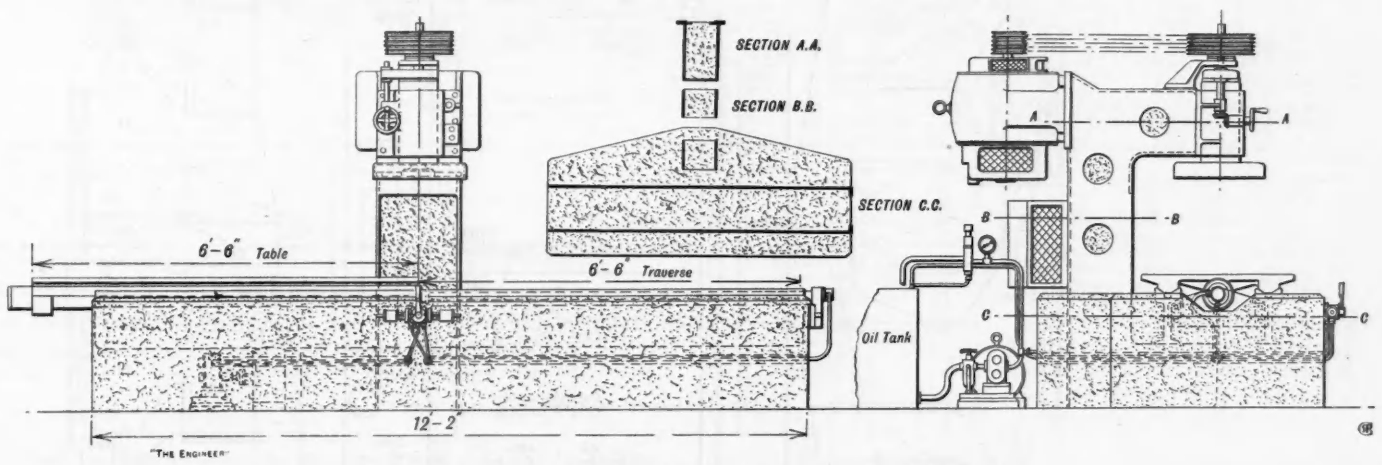
By these means the following results were achieved

(1) A very considerable saving in cast iron.

(2) A very considerable saving in pattern costs, as the patterns were few and of a simple nature.

(3) The machining and fitting costs were very greatly reduced.

(4) There were no erecting costs, as the machine was built on site.



SPECIAL PLANING MACHINE MADE OF CONCRETE AND CAST IRON

(5) The machine was built and put to work in a very short time.

As a matter of interest, I enclose a drawing of the machine, which, I may add, has been in service for some weeks with the most satisfactory result.

I must apologise for the drawing, but I am afraid that, due also to the times, this was "cut," as well as the cast iron.

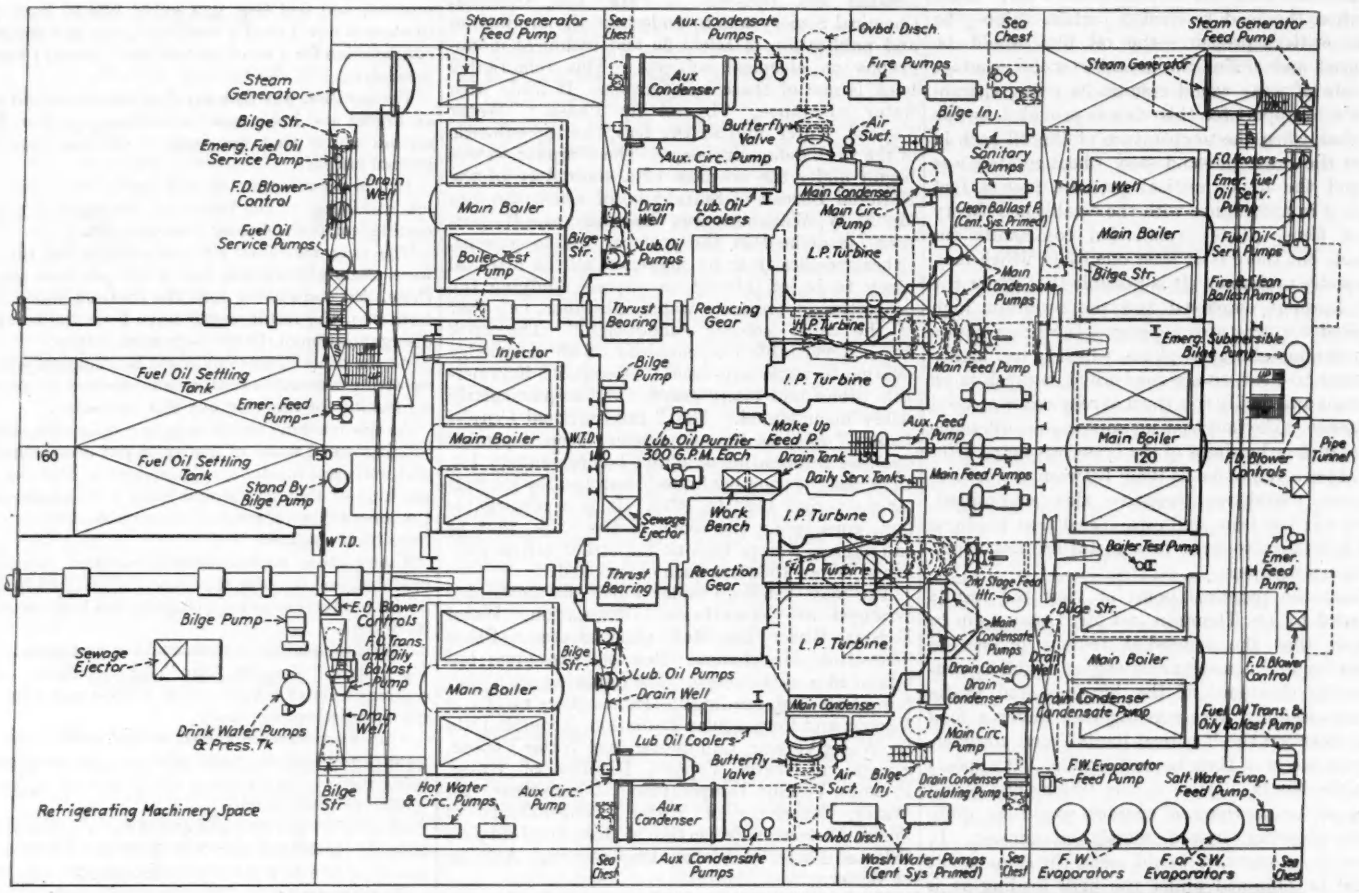
It may further interest you to know that the approximate weight of this machine, not taking into account the electrical equipment, is 10½ tons, the "rough" weight of the iron castings employed just under 2½ tons.

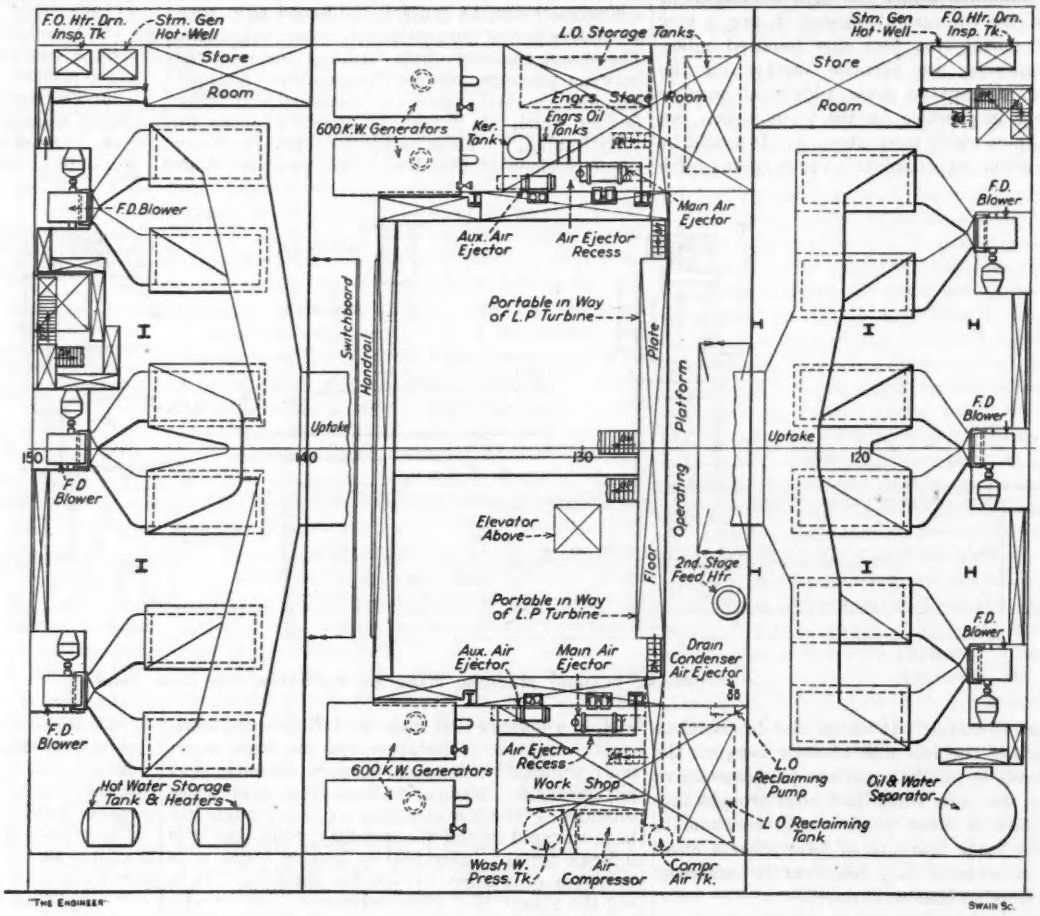
H. KENT-NORRIS,
Managing Director.

The Newbury Diesel Company, Ltd.,
King's Road, Newbury,
September 6th.

UNITED STATES LINER "AMERICA"—PLANS OF ENGINE AND BOILER ROOMS

(For description see opposite page)





"THE ENGINEER" SWAIN Sc.

The United States Liner "America"

No. IV

(*Continued from page 175, September 13th*)

HAVING in our previous three articles dealt with the hull construction and the passenger accommodation of the flagship of the United States Lines, the twin-screw geared turbine steamship "America," we now proceed to consider her propelling machinery.

General Machinery Design

The design of the machinery, like that of the hull of the "America," already described, represents a compromise between the ideas of at least four elements, the United States Maritime Commission, the owners, the United States Lines, the U.S. Navy and the builders, the Newport News Shipbuilding and Dry Dock Company. The machinery lay-out was naturally strongly affected by the fact that the vessel was primarily to be a running mate for the "Manhattan" and "Washington," which had already been in service for several years, had given excellent satisfaction to the owners and had established a splendid reputation with the travelling public. The power was increased just enough to give a little more margin of speed for making up lost time when required. Presumably, the vessel would often be operated by crews recruited from the other two vessels, and therefore machinery arranged in a somewhat similar manner to theirs would be advantageous.

A careful preliminary study was made of the service record of the "Manhattan" and "Washington" with a view to retaining what was good and making such improvements as seemed practicable. For this reason many of the general features were retained, such as twin screws, triple turbines with reduction gears and six boilers. The steam pressure and temperature were advanced somewhat from the previous practice and the high-pressure turbine was made of the impulse type throughout, increased in speed and fitted with double reduction gearing. The intermediate and low-pressure turbines are of moderate speed and single reduction is retained, the main gear being the largest marine gear so far produced in the United States. The boilers were made of the encased type, which permits the obvious advantage of open stokeholds. Owing to the increased beam it was found practicable to arrange all the propulsion auxiliaries in the engine and boiler rooms, thus reducing the length of the machinery space and of the main steam pipes.

The main condensers were arranged beneath the low-pressure turbines instead of above, thereby ensuring reliable drainage from the turbines at all times, and condenser circulation by scoops was retained. This arrangement, which is an offshoot from naval practice, has been found most satisfactory in service, is probably of equal efficiency with pumps and has the advantage of saving space and of eliminating the necessity for maintaining two vital constant-running auxiliaries.

The contaminated steam system was retained, but reduced in capacity and complexity. The main feed and condensate system is of the completely closed deaerating type.

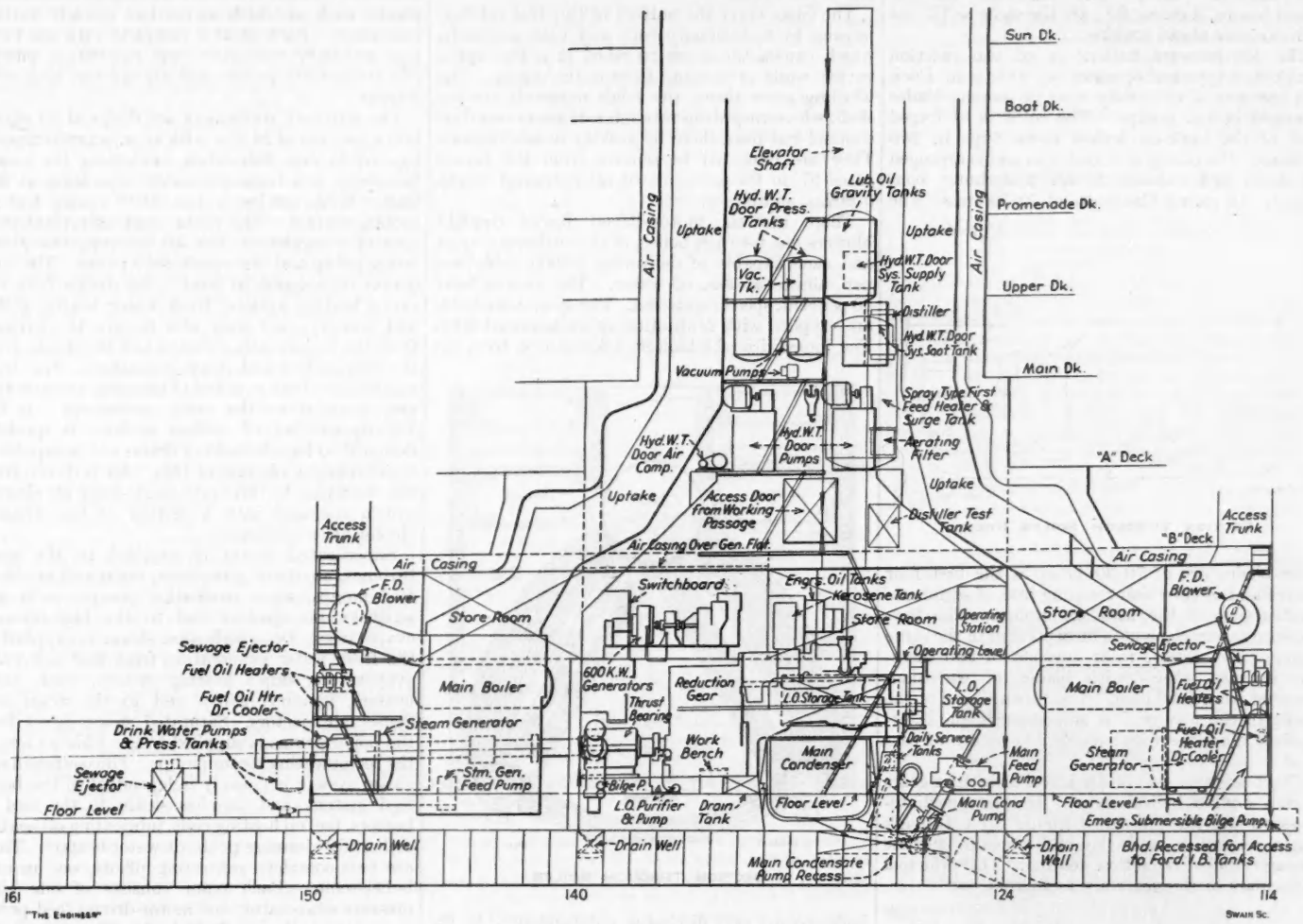
Reference to the drawings reproduced herewith will show that there is in the arrangement finally adopted a noticeable absence of non-vital automatic equipment in marked contrast to the present-day tendency, the operators preferring to rely on the results obtainable with a trained and dependable personnel.

Main Turbines and Boilers

The accompanying plans and elevation of the machinery spaces show clearly the arrangement adopted. The main turbines were designed and built by the Newport News Shipbuilding and Dry Dock Company, the builders of the ship. Each set of turbines consists of one high-pressure, one intermediate-pressure and one low-pressure turbine in series. The turbines are designed to deliver to the propellers a total of 34,000 S.H.P. at 128 propeller r.p.m. when supplied with steam at 400 lb. gauge and 715 deg. Fah. at the chests and exhausting at 29in. vacuum, and are designed for approximately equal distribution of power. The astern elements are designed to deliver a total of 19,500 S.H.P. at 95 propeller r.p.m. with steam at 385 lb. and 715 deg. Fah. at the chest. The turbines are capable of operating continuously at 10 per cent. overload. Three hand-operated control valves on the high-pressure chest provide economical operation from overload to approximately 15 knots cruising speed.

Each set of turbines is protected against overspeed and loss of lubricating oil pressure by a governor system operating a steam-thrown quick-closing valve located between the throttle and high-pressure turbine chest. The overspeed element is on the low-pressure turbine and is set at 118 per cent. of the designed revolutions per minute.

All the turbine glands are of the labyrinth type. The gland on the inlet end of the high-pressure turbine has one additional leak-off pocket which vents into the high-pressure receiver. The leak-off vapour is discharged by a fan to the gland leak-off cooler section, which is incorporated in the main air ejector after condenser. Three turbine bleeder connections are provided to supply steam for feed



FORE AND AFT SECTION THROUGH ENGINE AND BOILER ROOMS

Propelling Machinery Particulars.

Type of Machinery	Twin-Screw Geared-Turbine
Number of Turbines each Unit	Three, HP, IP, and LP in series
Total Designed Normal Output	34,000 Shaft Horse Power
Astern Power	19,500 Shaft Horse Power
Ahead Speed of Propeller Shaft	128 R.P.M.
Astern Speed of Propeller Shaft	95 R.P.M.
Designed Speed	22 Knots
Cruising Speed	15 Knots

Boiler Installation.

Number of Boilers	Six
Type of Boilers	Babcock and Wilcox three-drum express-type oil-fired
Steam Pressure at Turbines	400lb. per sq. in.
Total Superheated Steam Temperature	725 deg. Fah.
Maximum Designed Steam Pressure	500lb. per sq. in.
Total Evaporating Surface all Boilers	63,000 sq. ft.
Total Evaporation Normal	315,000lb. per hour

Boiler Installation (continued).

Total Maximum Evaporation	346,000 lb. per hour
Air Heater Surface each Boiler	6,560 sq. ft.
Air Temperature leaving Heater	307 deg. Fah.
Funnel Gas Temperature leaving Heater	312 deg. Fah.

Auxiliary Generating Plant.

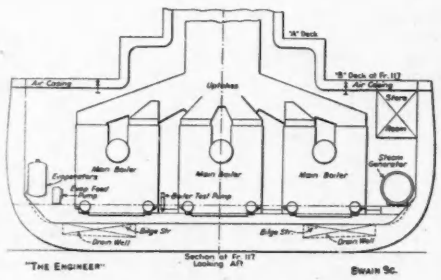
Type	Turbo-Generator
Number of Generators	Four
Total Designed Output each Generator	600 kW.
Total Output all Sets	2400 kW.

heating and for the fresh water evaporators. All turbines are equipped with pivoted segmental type thrust bearings.

The high-pressure turbine is of the single-flow impulse type and operates at 3300 r.p.m. It has one two-row wheel and seven one-row wheels, all forged integral with the shaft. The rotor is of forged steel and the casing, chest and diaphragms of cast steel. The diaphragm nozzle plates and nozzle blocks are of corrosion-resisting iron. All the blades are machined and have integral roots.

The intermediate-pressure turbine is of the reaction type, single flow, and operates at 1500 r.p.m. It has a total of forty-six rows of moving blades in six groups. The rotor is of forged steel of the built-up hollow drum type in two sections; the casing is of cast steel. The first four groups of blades are of Monel metal, end-tightened, and the last two groups are of 70–30 brass. The high-pressure astern element is incorporated in the same casing. The astern rotor consists of one three-row impulse wheel. The materials for the astern blades, nozzles, &c., are the same as for the high-pressure ahead turbine.

The low-pressure turbine is of the reaction double-flow type and operates at 1500 r.p.m. Each half has a total of twenty rows of moving blades arranged in ten groups. The rotor is of forged steel of the built-up hollow drum type in two sections. The casing is of cast iron and is arranged for downward exhaust to an underhung condenser. All casing blades are of 70–30 brass. The



SECTION THROUGH BOILER ROOM

rotor blades are of 70–30 brass in the first four groups and of corrosion-resisting iron of segmental construction in the last six groups. The low-pressure astern element is incorporated in the same casing. The astern rotor consists of two three-row impulse wheels with blades of corrosion-resisting iron, machined. The forward end of the casing in the way of first stage astern, the intermediate diaphragm and nozzle blocks are of cast steel.

There are two sets of De Laval reduction gears of the double helical type. The intermediate-pressure and low-pressure turbines drive through single reduction, and the high-pressure turbine through double reduction gearing. The principal particulars of the gears are as follows:—

	Pitch dia., in.	Face, in.	Helix angle degs.
High-speed pinions...	13·00		
High-speed gear ...	28·40	... two 15·0 ...	45
Low-speed pinions ...	14·80		
Low-speed gear ...	174·00	... two 25·5 ...	30

All the turbine rotors are connected to the pinions by claw type flexible couplings. The high-pressure high-speed gear is connected to the high-pressure low-speed pinion through a quill shaft and claw type coupling. All pinions are nickel steel forgings, 200 to 240 Brinell, the gear rims and the high-speed gear, which is solid, being of carbon steel, 160 to 190 Brinell. A spider, on which the low-speed gear is mounted, is made of special cast iron, bolted together in two halves. The high-speed gear housing is of semi-steel; the low-speed gear housing is of welded construction, with steel castings and plates. Shaft turning gear is mounted on the gear case.

Steam is generated by six Babcock and Wilcox water-tube, three-drum express type, oil-burning boilers, a section through one of which is shown in the accompanying drawing. The boilers are totally encased so as to operate under forced draught in open stokeholds and are fitted with superheaters, de superheaters and air heaters. The air casings are double, the outer surface being kept cool by allowing the outer space to receive a portion of the air direct from the blowers.

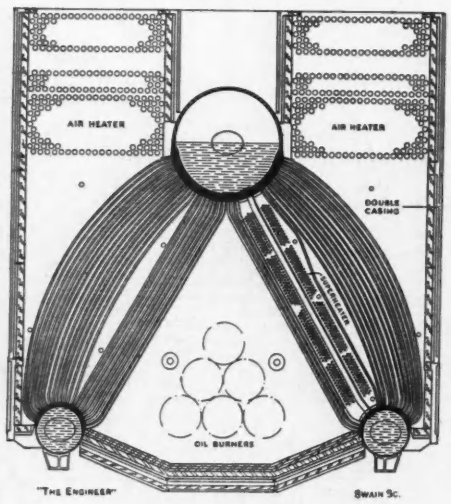
The boilers have a total evaporating surface of 63,000 square feet and are designed for a total evaporation of 315,000 lb. per hour normal and 346,000 lb. per hour maximum with 300 deg. Fah. feed temperature. The normal steam conditions at the superheater outlet are 425 lb. gauge and 725 deg. Fah. The boilers are designed for a maximum steam pressure of 500 lb. gauge. A saturated steam connection is provided on the steam drum of each boiler. A submerged coil type de-superheater is fitted in each steam drum. Each boiler is fitted with six mechanical atomising fuel oil burners.

The air heaters are of the horizontal tube type, arranged on each side of the boiler, and have a total heating surface of 6560 square feet of heating surface per boiler. Under normal conditions the air temperature leaving the heater will be 307 deg. Fah. and the funnel gases leaving the heater 312 deg. Fah.

There are two funnels having outside streamlined casings. The forward one, which is a dummy, houses the emergency generator and related equipment. Uptakes lead from each boiler to individual centrifugal dust catchers located above the fidley top, which have independent smoke pipes to the top of the funnel.

The gases enter the bottom of the dust catcher, passing by a stationary cone and vane assembly, which causes the gases to whirl in a free spiral vortex while proceeding toward the outlet. The whirling gases throw the solids outwardly to the shell, where they drop through side ports to a dust channel and from there by gravity to ash ejectors. They are expected to remove from the funnel gases 97 to 98 per cent. of all entrained solids, 0·002in. and larger.

There are six motor-driven forced draught blowers one for each boiler, of the turbovane type, and each capable of delivering 22,000 cubic feet per minute at 8in. of water. The motors have 50 per cent. speed regulation. The open stoke-holds are supplied with ventilation air as described later. The forced draught blowers take suction from the



SECTION THROUGH BOILER

boiler-rooms and discharge independently to the air heaters on each side of the boilers.

The main thrust bearings are independent of and located aft of the reduction gears. They are of the pivoted shoe type, six shoes ahead and astern, and are capable of absorbing a maximum thrust of 230,000 lb. in either direction. They are self-lubricating and are arranged for oil circulation from the turbine lubricating system.

The line shafts are 20¾in. in diameter and 21in. in the way of bearings. Each line of shafting is made of eight sections; each section is supported by two steady bearings of the ring-oiled type. The propeller shafts are 22⅝in. in diameter and are fitted with composition liners in two sections. The stern tubes are of cast steel in two sections, bolted together, and are fitted with long bearings lined with lignum vitæ. A torsionmeter is installed in each line of shafting.

The propellers are four-bladed, solid bronze, airfoil, 19ft. 6in. diameter, 18ft. 2in. to 19ft. 7in. varying pitch, 24in. rake and 24in. skew back. The developed area is 148·6 square feet and the weight approximately 20 tons each. The propeller design was based on exhaustive studies and model tank tests.

MAIN CONDENSING PLANT

The plant for each set of main turbines includes a single-pass main condenser, one circulating pump for manœuvring, two centrifugal condensate pumps, air ejectors, etc. The main condensers, designed and built by the Newport News Shipbuilding and Dry Dock Company, are suspended athwartships underneath the low-pressure turbines. The main circulation is by scoops, a regulating valve being fitted in each outlet branch to guard against undue condensate depression when operating in the North Atlantic during winter.

Each condenser has 16,000 square feet of cooling surface and is designed to maintain a vacuum of 29in. at normal power with 65 deg. Fah. injection temperature. The shells are of welded steel plate construction and the tube sheets of rolled Muntz metal. The tubes are 70–30 cupro-nickel alloy, expanded into the tube sheet at the inlet ends and packed with metallic and fibre rings at the outlet ends.

Each condenser is served by two sets of two-stage tube jet air ejectors mounted on a common combined inter and after condenser. The after condenser has a separate section which receives the air and vapour from the main turbine gland leak-offs. There are two auxiliary condensing plants, each of which serves two 600-kW turbo-generators. Each plant is complete with one two-pass auxiliary condenser, one circulating pump, two condensate pumps and air ejectors and condensers.

The auxiliary condensers are designed to maintain a vacuum of 28·5in. with an injection temperature of 78 deg. Fah. when condensing the steam flow from two turbo-generators operating at full load. Each condenser has 2400 square feet of cooling surface. The drain condenser plant consists of a condenser, two air ejectors, one circulating pump and one condensate pump. The condenser is designed to receive the drains from the ship's heating system, fresh water heater, galley and laundry, and may also receive the exhaust from the reciprocating pumps and the drains from the evaporators and steam generators. The drain condenser is four-pass and of the same construction and material as the main condensers. It has 150 square feet of cooling surface, is specially designed to handle flashing drains and is capable of maintaining a vacuum of 15in. Air is drawn from the condenser by duplicate single-stage air ejectors which discharge into a section of the dynamo ejector after condenser.

Superheated steam is supplied to the main turbines, auxiliary generators, main and auxiliary feed pumps, main circulating pumps, main and auxiliary air ejectors and to the high-pressure evaporator. De-superheated steam is supplied to the fresh water evaporators, fresh and salt water evaporators, ship's heating system, fresh water heaters, laundry, galley and to the drain condenser air ejectors. Saturated steam direct from the boiler drums is supplied to the whistles and to the reciprocating steam pumps. The contaminated steam system is entirely independent of the boiler feed system, and supplies steam to the fuel oil heaters, fuel oil heating coils, lubricating oil heating coils and swimming pool salt water heaters. There are two complete generating plants, one in each boiler-room. Each plant consists of one high-pressure evaporator, one motor-driven feed pump, inspection tank and drain tank. The evaporators each have a capacity of 7500 lb. of steam per hour at 125 lb. gauge.

(To be continued.)

Photo-Electric Meter Testing

INCREASED accuracy in testing sample meters used in the development of the modern single-phase watt-hour meter first led the General Electric Company of America to the adoption of the photo-electric method, and more recently to the introduction of the photo-electric tester. This new and compact unit is claimed to offer the advantages of increased accuracy, lower cost, and less eye fatigue when used for routine meter testing in the shop. In operation the device is automatic and employs a light beam, photo-tube, and relays to count the revolutions of the meter under test, and to start and stop the rotating standard in accordance with the meter-revolutions.

When used for testing a watt-hour meter, a concentrated light beam is focused on the disc of the meter by lenses in the light sources, as shown by the accompanying diagram. Twice in each revo.ution the light shines through the anti-creep holes in the disc on to the photo-electric tube beneath and causes impulses to be transmitted to the control box, in which the impulses are amplified and are used to operate a multibank rotary switch, which has selected contact fingers wired to a selector switch. By means of the selector switch and relays in the control box, the potential circuit of the rotating standard is closed

and opened in accordance with predetermined revolutions of the watt-hour meter.

With the "on-off" switch in the "on" position and the selector switch set for the desired number of revolutions, the start button is momentarily depressed. This energises the coil in the rotary switch and positions the contact wipers by advancing them one step or contact. Once positioned, the wipers will automatically advance one step for each impulse or two steps for each revolution of the meter tested.

After the start button has been momentarily closed, with the first impulse from the photo-tube, the wipers advance to the next contact, when a relay is energised and its contacts close the potential circuit to the rotating standard. Once started, the rotary switch will continue to rotate for 360 deg., and will automatically stop at its neutral position. But if it is desired to advance the wipers to the neutral position at a speed greater than two steps per revolution of the meter disc, a reset button is depressed and the wipers then motor to the neutral or home position by self-interrupted pulsing.

This is accomplished by an interrupter contact which is an integral part of the rotary switch. Each time the coils of the rotary switch are energised and the armature pulled in the interrupter contact automatically opens. Hence by depressing the reset button the coil is alternatively energised and de-energised in rapid succession, resulting in the wipers being rotated to their neutral position.

Writing in the American General Electric Company's *Review*, Mr. A. Abbott explains that to reduce the timing errors to a minimum, all relays are operated with direct current, the supply being obtained from the A.C. supply to the control box by rectification through valves inside the box. Precision tests show that the photo-electric testing equipment is accurate to 0·004 per cent. in one revolution or 0·0004 per cent. in ten revolutions. This accuracy is claimed to be higher than it is possible to read on a dial and higher than can be achieved with previous testing methods. Magnetic brakes on rotating standards alone have an inherent error, owing to their A.C. operation and because of variations in friction do not always stop the disc in the same length of time. The accuracy that can be obtained by the photo-electric tester, on the other hand, depends largely upon the rotating standard with which it is used, but in any case the accuracy will be higher than can be obtained with other methods because the timing errors are negligible.

The advantage of the photo-electric method of testing is shown to become apparent when it is compared with the three commonly used testing methods —(1) hand switch, (2) the gang method, and (3) the stroboscopic method. In the case of the hand-switch method, the operator starts a rotating standard by means of a potential circuit switch, counts the revolutions of the meter and stops the standard. The personal error in manipulating the switch is always present, but can readily be reduced to a small factor by increasing the running time, and with a skilled operator taking at least one minute of running time, this method has proved to be very satisfactory.

One method of speeding up testing in the meter shop is to connect a number of meters and a rotating standard to a suitable test circuit, so that when the switches are closed all the meters and the rotating standard operate together. Although the actual running time is the same as in the hand-switch method, the running time per meter is greatly reduced. For practical considerations, however, it is nevertheless necessary to stop the rotating standard at an exact number of revolutions, and this usually introduces additional lost time, which must be added to running time.

Several schemes have been devised to stop the rotating standard and meters automatically at the required number of revolutions, but they do not overcome the fundamental difficulty of the gang method, which arises in attempting to read the accuracies of the individual meters. If the problem is one of calibration only, and the meters are to be adjusted within certain limits, and no exact readings are required, there is no serious problem, but if exact readings must be taken on each meter, it is necessary to use a scale to measure the displacement of the discs in the individual meters or to employ some other method of estimating their accuracy. One American supply company has solved this problem by using reverse push buttons by means of which each meter disc is inched either forward of backwards to its original position so that it is possible to read the accuracy of the individual meter on the rotating standard, but this procedure must be repeated for each meter. Although the gang system is faster than the hand-switch method, special precautions must be employed to assure accurate readings.

For meter testing many stroboscopic methods have been suggested. Some make use of a large number of lines on the disc to permit the use of a stroboscopic light of increased frequency, this being desirable not only because more light is thus obtained, but also because of the greater accuracy that results. For adjusting meters at full load speed to within certain limits of accuracy, the stroboscopic method is probably without equal in speed, but when attempts are made to adjust at low speeds, such as encountered at light load, there is difficulty in obtaining a good stroboscopic image. Moreover, the inherent variation in the disc's speed makes it necessary to watch the stroboscopic image for at least one full revolution of the disc to be certain of what the adjustment should be, and this watching is a tedious business. Moreover, there is the additional difficulty of obtaining accurate "as found" and "as left" readings. Although these can be obtained, it is usually necessary to provide some means of changing the calibration of the rotating standard which may introduce an additional hazard in maintaining exact calibration of the standard.

The photo-electric tester offers possibilities for lowering the cost of testing by reducing the length of time and by eliminating repeated runs. The inherent accuracy of the equipment makes long running time unnecessary. For full load and lagging load tests, it is sufficient to take five revolutions of the meter to be tested, and a like number of revolutions of the rotating standard.

When making light-load tests, one revolution of the meter being tested will usually be compared with five revolutions of the rotating standard, the number of revolutions being approximately one half those used in the usual testing procedure. Repeated runs so frequently made to ensure that correct readings are obtained are eliminated by this method.

The savings in running time which can be realised are important, but even greater savings can be secured by using a twin type tester, equipped with two separate light beams and photo-tube units and one control box together with two rotating standards.

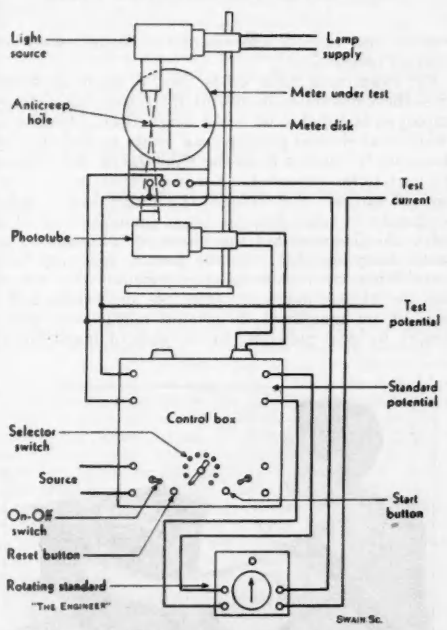


PHOTO-ELECTRIC EQUIPMENT TESTING WATT-HOUR METER

These are arranged so that as soon as a run is completed on one meter, the other meter can be started by a transfer switch. While one meter is running, the readings on the other are being recorded, calibration is being adjusted, or a new meter is being made ready for the next run. Thus running time is almost completely eliminated, and the operator can give his full time to recording data, adjusting load, and correcting calibration.

One of the greatest advantages claimed for the method is the ease with which accurate "as found" and "as left" readings are obtained. Many American companies take "as found" readings on all meters returned to the meter shop before inspecting them. Ordinary cleaning and inspecting of the bearings in the meters restores in many instances the original accuracy, so that no further adjustments are necessary, and only "as left" readings need be taken. Polyphase meters and meters of the single-phase disc type without anti-creep holes in the disc can be tested with the photo-electric tester by attaching a small mirror to the shaft of the meter. No changes or marks need be made on the meter disc, and even the older types of meters can readily be tested, using either the anti-creep holes or a mirror.

The hand-switch and gang methods of testing meters require the greatest skill. Unless exceptionally long runs are made to mask the personal errors of operators, a long period of training is usually required. Testing skill is gained more readily with the stroboscopic method, but close concentration is usually required, and may prove tiresome. The photo-electric tester requires minimum training time because with modern test panels loads are readily adjusted, and the testing equipment automatically controls the rotating standard.

The photo-electric method rates the highest with respect to speed of testing, followed by gang testing or stroboscopic testing and hand-switch testing. This applies to testing in a meter shop with good facilities for handling meters and adjusting loads. For calibrating purposes, the photo-electric tester provides the fastest method, because it eliminates running time. One of its greatest advantages is the ease with which readings of exact calibration can be obtained.

Eye strain is one of the most common causes of fatigue. It is present with stroboscopic testing, especially if the image is indistinct, as is often the case with light-load tests. The hand-switch method is also tiring, particularly when the operator performs routine testing in the meter shop and must continuously watch the rotating meter discs. With the photo-electric method, however, eye strain is completely eliminated. The operator not only need not watch the disc but when full advantage is taken of this new method, he is actually prevented from doing so by performing other tasks while the meter is running.

With all methods, with the exception of the photo-electric method, the test accuracy depends largely on the operator. The skill required to obtain even reasonable accuracy with the hand-switch method is well known. Chances of error with the gang method may be somewhat less because of the fact that the meters and standards are started and stopped together, but even here skill is an important factor. Constant attention is required with the stroboscopic method, but since the equipment associated with the photo-electric method is automatic, accuracy is not determined by the operator. The ability of the photo-electric tester to repeat readings on the same meter gives the operator confidence in his results, and a real incentive to do his best.

Magnetic Crack Detection

CRACK detection by electro-magnetic means, confined originally to finished parts, such as aeroplane engine parts, after test or subsequent overhaul, has been extended to the use of the method before sending parts to the stores and before assembly. Moreover, it has been deemed desirable in certain cases to employ the crack detector at an early stage in manufacturing operations, particularly where high machining costs may be involved before a crack is discovered. Another advantage of the electro-magnetic detector is that it can be employed with advantage for controlling the quality of materials supplied to the works. Such things as stampings, forgings and bars can be

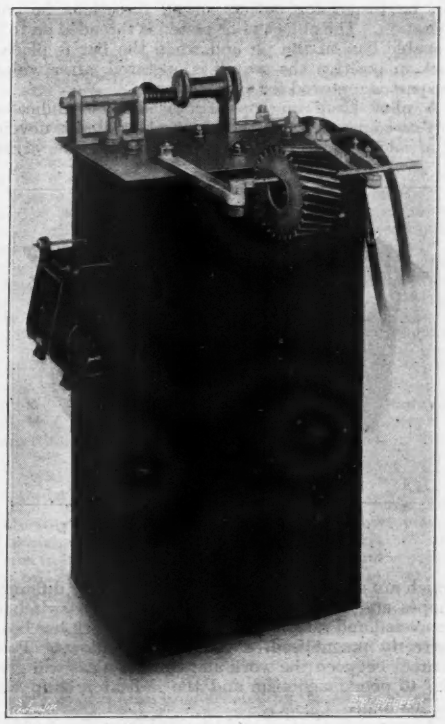


FIG. 1—MACHINE WITH RING JIG LEVER HEAD

tested and faulty material rejected. Another advantage claimed for the system is that it consideraby saves time devoted to inspection.

For the detection of surface defects in ferrous materials two electro-magnetic methods, employed by Johnson Fel Electric, Ltd., of Garden Street, Sheffield, are in common use. The first consists of slightly magnetising the part under test by supporting it between the poles of an electro-magnet, the suspected crack being placed so that it is at right angles to the path of the magnetic flux. Following magnetisation the part is immersed in or swilled with a fluid carrying finely divided iron particles in suspension, when cracks are clearly indicated by the particles lining up along the crack, owing to the magnetic poles formed at these points. Since it is undesirable to leave parts in a magnetised condition,

means must be provided for demagnetising them before assembly.

In the other case the field is produced in the part to be examined by passing a heavy alternatng current through it, instead of using an external magnetic field. For inspecting long bars, &c., this method is useful, but will only show longitudinal cracks, &c., although it has the advantage that demagnetising is unnecessary after testing, as magnetism is only present along the actual crack. The current passed through the part in accordance with this method is in the nature of an impulse of very high value for short duration.

As a result of their small size and portability these machines are particularly serviceable. For easy transport handles are fitted at each end. When long bars, tubes or heavy parts have to be examined

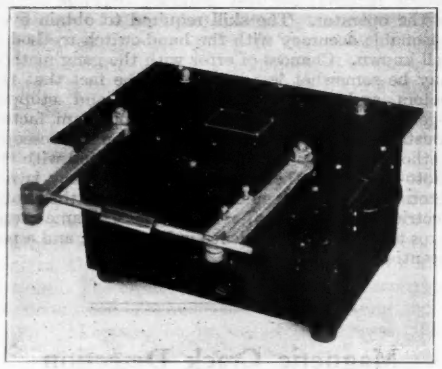


FIG. 2—MACHINE WITH RING JIG

cables of $\frac{3}{8}$ to $\frac{1}{2}$ square inch area should be attached to the machine and fitted with a pair of clamps to make good electrical contact with the ends of the bar or tube. It has been found in the cases of intricate and heavy parts, such as crankshafts, that if the part is supported in cast iron vee blocks lined with brass or copper gauze, good contact can be made with the use of clamps or fixtures, it being, of course, necessary to provide connections on the vee blocks to connect up the machine.

With the Johnson-Fel ring jig supplied with the machine parts such as rings, ball races, pinions, gear wheels, gudgeon pins, or any component with a hole can be tested for defects in all directions in one operation. The object to be tested is threaded on to a movable bar on the jig and when the bar is placed back in position the switch is operated, after which the part is removed for examination.

A pilot lamp on top of the machine indicates correct connection. If the part to be tested is devoid of a hole it is simply laid across the machine arms,

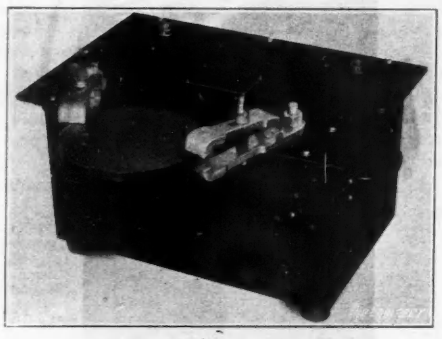


FIG. 3—USE OF CLAMPS

which are adjustable to take work of widely different shapes and sizes. When the press button switch is depressed and released rapidly and the work has been correctly magnetised, a second lamp glows. Poor contact between the work and contact arms will give rise to poor magnetism and the indicator lamp will fail to light.

After magnetisation and removal from the machine the object under test is treated with detector ink, which may be applied by dipping the article into an ink bath, by pouring the ink over the work, whilst suspended over the bath, or by spraying the part with ink. Owing to particles of iron lining up along the cracks the presence of such defects will easily become visible to the naked eye. If doubt exists as to the presence of cracks, the matter can be settled by wiping the suspected area with a rag and applying another supply of ink.

Long bars or tubes may be examined individually by clamping the machine cables at each side of the suspected area and then gradually moving the clamps along the whole length of the bar until it has all been tested. Satisfactory examination of the end faces of large-diameter bars or rolls can be accomplished by making diametrically opposite contacts by means of suitably arranged clamps.

The composition of the material determines the maximum length or diameter of the bar under investigation; the higher the carbon and the harder the bar the greater the length or diameter that can be tested in one operation. Another matter which the composition of the material determines is the length of time during which the magnetisation lasts. With very low-carbon steel the magnetising effect may remain for about six hours, whilst with the higher-carbon steels, alloy steels and hard steels the magnetising effect may last for three months or more. When magnetised by the Johnson-Fel machine specimens do not show any external field unless a crack is

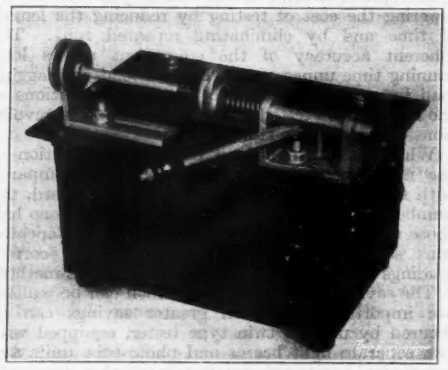


FIG. 4—SET-UP FOR REPETITION PARTS

present and appear non-magnetic when tested for residual magnetism.

For examining fillet welds, &c., in built-up structures these machines are useful, if the welding material employed is capable of being magnetised. Cracks at welds or at riveted portions can easily be detected by clamping the cables from the machine at each side of the part to be inspected. For inspection during overhaul of aircraft particularly the larger kinds, using composite construction or large quantities of steel tube, the Johnson-Fel machines are claimed to be particularly suitable. In the past it has only been permissible, the makers of these machines explain, to use the electro-magnetic principle on bright rolled bars or on machined or ground surfaces of parts. Resort to local polishing in the case of black bar or

FIG. 5—TESTING CUTTING TOOLS

rough stampings or forgings has been necessary in less recent times, but coloured inks show up plainly against a dark surface and make it possible to test the whole of a steel stamping or forging in its unmachined condition. Instead of coloured detecting ink, satisfactory results have been secured on black bar by applying to the bar a thin coat of aluminum paint.

In Fig. 1 is shown a Johnson-Fel machine with a ring jig lever head; in Fig. 2 a machine with a ring jig for testing gudgeon pins, gear wheels or any article that will slide over a $\frac{3}{4}$in. diameter bar; in Fig. 3 a machine with clamps for use with irregular-shaped specimens; in Fig. 4 a machine with a lever head for testing bolts and other repetition parts; and in Fig. 5 a machine used for testing high-speed cutting tools.

Packing Material Substitutes in Germany

THE following notes are taken from a report of the American Consul-General at Frankfurt-on-Main:—

One of the serious problems affecting Germany's war-time economy is an adequate supply of packing materials. Prior to the outbreak of war it was necessary to institute extensive measures of economy and substitution in the use of packing materials, and during the war these measures have become greatly intensified. Germany's packing material problem arises from the fact that to a high degree the nation is dependent upon foreign sources for the requisite raw materials—wood, wood pulp, tin-plate, jute, and other fibres, &c. The leading packing materials obtainable from domestic sources are glass and plastics, and so great is the demand for substitute containers made of these materials that the producing companies are now taxed to utmost capacity.

No entirely accurate data of Germany's requirements of packing materials are available, but their immense scope is suggested by official estimates that they represent a value of 3 billion* marks annually, calculated upon the basis that around 5 per cent. of the total value of the national production is represented by the cost of packing materials. Owing to refinements in the distribution of merchandise, extensive marketing of goods in individual containers rather than in bulk, increased use of packing materials, multiple wrappings, and elaborate packaging for improving the market attractiveness of products, Germany's current requirements of packing materials are far greater than during the World War. On the other hand, technical achievements of recent years, development of plastic materials, new types of cellulose containers, impregnated articles, coated metals, &c., have widened the possibilities for substitution of more abundant for scarce materials. Despite progress in substitution, however, packing materials generally are very scarce, and in some branches of industry manufacturing operations are retarded by shortages of requisite containers. Efforts toward substitution have been impeded by difficulties presented by shortages of the substitute raw materials, established technical methods employed by various manufacturing industries, such as the use of automatic packaging machinery, and transport factors such as shortages of railway rolling stock, restrictions upon use of automotive vehicles, and high transport charges for empty containers—all tending to render difficult and expensive the use of substitutes and re-use of old containers.

Chief among substitute measures for easing the container shortage have been the substitution of paper for jute sacks, glass for tin-plate and other metal sheet containers, paper for wood, and impregnated cardboard for metal sheet, and the careful recovery, repair, and re-use of all kinds of containers and packing materials, barrels, boxes, sacks, &c., wherever possible. Measures for accelerating the return of empty containers to filling plants, reduction of stocks of goods in containers, and of empty containers in the hands of distributors have contributed to easing the container shortage.

One of the most notable substitution achievements has been the replacement of tin-plate to a considerable extent by other materials in the manufacture of containers, such as untinned sheet, glass, and impregnated cardboard. As early as 1937 the use of tin-plate was forbidden for packaging such articles as biscuits, cigarettes, shoe polish, and related goods. Upon the outbreak of war the use of tin-plate was forbidden for packing conserved foods and the use of tin for manufacturing collapsible tubes was also forbidden. Owing to the acute shortage of aluminium caused by the war, it was impossible to base the manufacture of either food containers or collapsible tubes upon this metal, as had been previously planned. For meeting this situation the food packing industry resorted to various expedients, such as increased distribution of low-temperature frozen foods, use of untinned metal containers, and glass containers. For dispensing with the use of tin, containers are now used made of untinned sheet covered by a film of synthetic resin lacquer, and plans have been drawn up for the large-scale manufacture of untinned-plate cans treated by the Bonder phosphate rust-proofing process. The heavily increased demand for glass containers has given such an immense impetus to the glass container industry that, despite operating at full capacity, it has been unable to supply all of the demand.

Research work already in progress before the war for developing collapsible tubes made of plastic materials as substitutes for metal became greatly intensified, and it is reported that five or six different types of tubes made of these materials have been developed that are serviceable for packing various materials hitherto marketed in metal containers. It is stated that already production of each of these new types of plastic collapsible tubes amounts to over 1,000,000 tubes per month.

Materials like paints, floor wax, automobile lubricants, oils, fats, and cough remedies, which formerly were packed in metal cans, are now marketed in new types of impregnated cardboard containers. Some of these containers consist of the main body or casing made of impregnated cardboard with tops and bottoms of untinned metal sheet. Containers made of these combined cardboard and metal materials have achieved success, especially for packing automobile lubricating oils, fats, dry chemicals, &c. A specially treated fat and waterproof cardboard known under the name "Perga" has been found particularly suited for making these combined containers. "Perga" cardboard can be used as an insert for containers made of cardboard or cellophane for packing various kinds of products.

Standardisation of packing for various lines of products—to mention only such a leading one as cigarettes—as well as dispensing with packing altogether for various other products, such as soap, have enabled extensive savings to be made in consumption of cellulose, wood, and other packing

* One U.S. billion = 1000 millions.

materials. Considerable savings in cellulose have also been achieved by substitution of inferior grades of packing paper for more costly types, such as chromo and chromo-substitute carton, as well as the prohibition of carton boxes and other outside containers for products already wrapped in paper wrappers.

Sixty Years Ago

Big Guns and Locomotives

The two most interesting articles in our issue of September 17th, 1880, dealt with the big gun question and Stephenson's "Rocket." The number included also a supplement on tracing paper of a set of compound marine engines built by Wigham Richardson and Co. for the "Ville d'Oran" and the "Ville de Bône," of the Compagnie Générale Transatlantique. "The Gun Question" was presented in a leading article, which criticised with the freedom of the day a special committee, appointed as a result of the bursting of the gun in H.M.S. "Thunderer," to examine the whole subject with thoroughness. It will be recalled that it was decided to test the second "Thunderer" gun to destruction and that on February 3rd it was successfully burst. "Surely," we wrote seven months later, "it is now high time to ask to what purpose? Was the uneasiness of the country caused by bursting of one gun allayed by the bare fact of bursting another? Or was the second gun burst to teach us something? . . . A series of experiments of peculiarly public interest is concluded in the beginning of February, and in the beginning of September we remain without a hint as to the verdict of the committee. Are we to suppose that General Gordon and his committee have gone to sleep, or that they have sent in a report of such a character that it is better that it should not be made public?" Proceeding, we discussed the suggestion which had apparently been irresponsibly advanced that other guns should be tested to destruction, and submitted that since the object was "to learn the actual limit of endurance of each metal, and its behaviour when strained beyond that limit," that it was not necessary to make experiments with elaborately finished guns, as they could be carried out with small cylinders. . . . The article on the "Rocket" was timely because it was just fifty years since the opening of the Liverpool and Manchester Railway. It was No. IX of a series entitled "Links in the History of the Locomotive," which has gone on intermittently ever since, although numbering has ceased. The article was accompanied by a whole-page drawing made from the model which was then in the possession of Mr. G. R. Stephenson and which he had lent to us. There is, however, no pretence that the model was "true to life," and it could be contrasted with more reliable drawings which we reproduced.

TECHNICAL REPORTS

War-time Building Bulletin No. 8. The Building Research Station.—This bulletin is now obtainable from the Stationery Office. It is in three parts and deals with the construction of factory buildings and a heating system for war-time factories. Part I deals with the walls and piers for the factory types already described in Bulletins Nos. 1, 4, and 5. The walls are designed to give the code standard of protection against bomb splinters and to utilise the thickness necessary for this purpose in carrying the load of the adjacent roof and in resisting the entire wind forces imposed on the walls. It is thus possible to dispense with steel in the outer walls, while enabling them to resist forces which, if passed on to the roof members in the ordinary way, would have made necessary an overall increase in the weight of steel in the roof structure. Three column designs are given; the first consists of a shell constructed in brickwork on the flat, which can be filled with a brick or concrete core; the second is a similar design with the shell constructed in brick on edge; and the last, a pre-cast concrete shell as a permanent shuttering for a concrete core. In almost all the types some reinforcing steel has been necessary, but the amount is considerably below that required for steel stanchions. The piers are slightly more bulky than the steel stanchions. Working drawings of the wall and column designs are available on application to the Building Research Station, price 2s. 6d. per type, post free. In Part II a design using welded tubular steel trusses and purlins is given as an alternative to the steel structural designs previously issued. The new design has been prepared by Tubewrights, Ltd., and is claimed to show a distinctly useful economy in the weight of steel. Part III of the Bulletin discusses a design submitted by Mr. J. W. Cooling, M.Sc., for a heating and ventilating system for war-time factories, such as those outlined in previous Bulletins. The design avoids loads suspended from the roof and the heating units are decentralised, giving additional resistance to air attack; adequate ventilation under black-out conditions, and conservation of metal are other factors taken into consideration. The warm air is forced through underground ducts, by means of fans, and is distributed throughout the body of the factory through rising ducts at each stanchion. Direct-fired heaters placed at suitable points around the factory are used. Details for the construction of the ducts are given, and for a typical factory design it is estimated that a 40 to 50 per cent. economy in steel can be obtained.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

The Scrap Position

The scrap situation is easier probably than at any time since the commencement of the war. This does not mean that the requirements of the steelworks have diminished in any way, but the propaganda campaign for providing scrap metal has undoubtedly been successful in bringing out considerable quantities of the lighter material as well as other descriptions. The facilities for handling have also been improved and transport difficulties have been largely overcome. The scrap merchants have been able to increase their deliveries to the works considerably, and the latter are taking every opportunity that presents itself to lay in stocks. In some cases the works are unable to accept any more from stock, but this position is not likely to last for long. In the Midlands there has been a general suspension of deliveries by the steelworks and, as a result, the trade has become dull. In other districts there seems to be an abundance of certain categories which has led the makers to ask their suppliers to hold up deliveries for a time. In the South Wales market it is reported that new business in scrap is difficult to transact and is likely to remain so until the congestion has been overcome. Many of the merchants are also finding that their yards have become over full and are anxious to pass on the material to the works. Whilst this is the situation in the home market large imports from the United States are coming to hand and helping to fill up the works' yards. It is pointed out that in several parts of the country considerable dumps exist and that these should be a safeguard during the winter months against a shortage such as developed last year. The ironfounders are taking only moderate quantities of scrap, although the best quality material is passing more readily into consumption.

The Pig Iron Market

The position of the pig iron market does not show much change from week to week. On the North-East Coast there has not been a great deal of interference with production from air raid activities and the more plentiful supply of raw material, particularly of blast furnace coke has enabled outputs to be extraordinarily well maintained. The producers are concentrating principally upon the manufacture of basic iron, and the quantities of this grade now available for the steelmakers seem to be satisfactory. There has been an increase in the production of Cleveland No. 3 foundry which is in good request when it is obtainable. The larger supply of cast iron scrap has relieved the pressure upon the pig iron makers to some extent. The official quotation for No. 3 is 120s. d/d Teeside and 2s. extra d/d North-Eastern area. This includes 5s. per ton loyalty rebate. The export quotation remains at £6 f.o.b., but this is a purely nominal figure as no overseas business has been transacted. In the Midlands the situation is becoming rather tight in the case of some descriptions of iron. The production of high phosphoric pig iron has been reduced and at the same time the demand for it has expanded owing to more of the light castings foundries having been given Government war contracts. There is, however, sufficient to meet the requirements of consumers as a number of establishments are still working short time. Low phosphoric foundry iron is in strong demand from the makers of engineering castings. Some stringency exists in this department and if it were not for the precautions taken by the Control some consumers would probably have to go short. An increase in production is expected in this section of the industry and this will be welcomed by a large number of users. Consumers of pig iron in Lancashire are principally engaged upon war work and are taking up large tonnages. Some of the jobbing foundries report that they are not receiving the same amount of work as a month or two ago. The Scottish pig iron producers are principally working on the production basis. The supply of raw materials is on an improved scale, and this has helped to maintain output.

Scotland and the North

The maintenance of a high rate of production in Scotland is assisted by a plentiful supply of raw materials and in spite of the increasingly heavy demand consumers engaged on essential work are receiving regular supplies. The shipbuilding yards are absorbing large tonnages of plates and sections, and as there is a big programme of naval and military construction in hand there is no likelihood of any slackening in the demand for a long time. The constructional engineers are also busy, although some firms are not so actively employed as they were a short time ago. The request for joists and sections, however, has diminished but little as other trades are pressing for supplies of this description of material, which is required in large quantities for a variety of purposes. The demand is equally strong for large and small sizes of billets and good supplies are now available for the re-rollers and although in some cases firms find that the particular size or qualities they require are not readily obtained, the general position is satisfactory. There is also a strong demand for iron bars, and in some cases mills are so well booked that they are reluctant to accept fresh business. The situation in the sheet trade has become a little easier, and although a big proportion of the production is being taken for service requirements, a certain amount of business has been transacted in galvanised sheets for export. All consumers of iron and steel in Lancashire are fully employed, and practically all of them are engaged upon war work of one kind or another. There is an insistent call for heavy steel products and the lighter branches of the trade have had urgent calls made upon them. Locomotive builders and engineering works generally are busy and are taking up large tonnages of steel. The steelworks on the North-West Coast are operating at capacity and their production of structural steel, billets and hoops is on an impressive scale.

The Midlands and South Wales

Large tonnages of manufactured steel are being turned out by the works in the Midlands, but notwithstanding the heavy production the demand for practically all descriptions is in excess of the supply. Whilst there have been a certain number of unavoidable stoppages, the steps taken by the manufacturers have maintained a regular supply to consumers engaged on war work. Large imports of semis have relieved the stringency in this section of the trade and the re-rolling establishments are able to operate at capacity. The demand, however, for small bars and sections is on a huge scale, and it is with difficulty that the makers meet the urgent demands of consumers. The producers of heavy and light structural steel are pressing outputs to the utmost, but the demand seems to be increasing and even greater efforts are likely to be required. The call for plates from the shipyards, locomotive builders and tank makers is at a very high level and some tightness is noticeable in supplies. Munition works are calling for increased quantities of steel of all kinds and owing to the importance of their work their requirements have to be met. By careful supervision of distribution this is achieved and essential work is well provided for. The steel industry in South Wales is pressing production to the utmost. There is a huge demand for steel of all descriptions, and the heavy steelworks, in particular, have difficulty in fully meeting the requirements of their customers. The tinplate market has become rather quiet owing to the drop in the export demand. The necessity for providing steel for more urgent purposes has resulted in some limitation of the quantities allocated to the tinplate trade; but makers are reducing the large tonnages of orders on their books.

Copper and Tin

The consumption of copper in Great Britain continues on a heavy scale, and so far there have been no serious interruptions to supplies. The brass makers are taking large quantities and good tonnages are also passing to the electrical trades. In the United States the market, after a burst of active buying, has become quieter. In the domestic market primary producers are maintaining their price at 11·50 c., but there is little buying at this figure. The Customs smelters have dropped their price to 11·25 c., whilst the export quotation is maintained at 9·90 c. There is, however, no export business passing, and traders are inclined to take a gloomy view of the prospect of an improvement for a long time to come. The manufacturers of copper products in the United States are exceptionally busy, and apparently American rearmament orders are now reaching this section of the industry. It is understood that considerable business is in hand on British Government account. It is not expected that the American domestic market will improve for a time, owing to the considerable purchases made by consumers about a week ago. . . . An easy tone has prevailed in the tin market, and prices have continued the downward movement, which commenced early this month. This seems to be principally due to liberal offerings by smelters and to the reluctance of traders to hold any quantity of the metal. The difficulty of war risk insurance may in part account for this, and also for the expansion in the contango to £4. There has been a moderate amount of business passing on the London Metal Exchange, which may be explained by the fact that this is the only market in which free dealings are possible. It is anticipated that export licences will be granted more freely, as the stocks in this country show a tendency to increase. When the smelters refrained from selling early in the week the price immediately stiffened.

Lead and Spelter

The situation in the lead market does not materially alter from week to week, and the development of aerial warfare has not affected the position. There seems to be no lack of metal in this country, and supplies are being regularly distributed to the consuming trades. Practically all manufacturers of lead products are engaged upon work connected in some way with the war, and this may perhaps account for the comparatively small amount of export business passing, since there appears to be no real difficulty in obtaining licences for lead to manufacture exportable products. The output of lead pipes and sheets has, of course, been affected by the practical cessation of private building. In the United States dull conditions prevail, but buying is expected to increase shortly when consumers start to cover their autumn needs. American statistics give the United States imports of lead in July as 21,959 tons, compared with 51,643 tons in June, whilst the exports in July were 1173 tons, against 1195 tons in the previous month. . . . Large quantities of spelter are passing into consumption in this country, and the situation appears to have eased to some extent, since not only are the war industries receiving full supplies, but a certain amount of metal is now obtainable for export. Most of the spelter distributed to consumers now consists of high-grade metal, large tonnages of which are being used by the die sinkers. The brass-making industry also is operating at capacity. A certain number of consumers would like to receive more G.O.B. metal, but this seems to be in short supply, as in pre-war days it was principally imported from the Continent. In the United States some surprise is expressed that the demand is so well maintained, considering the large quantities bought by consumers a few weeks ago. The American rearmament programme is no doubt partly responsible, and producers report that they are receiving all the orders they want.

Notes and Memoranda

Rail and Road

A CANADIAN HIGHWAY.—A high road, 165 miles long, from Mont Laurier to Senneterre, Quebec, has been formally opened by Hon. T. D. Bouchard, Quebec Minister of Highways and Public Works. It links the southern part of the province with the north-western mining district. Its construction has lasted seven years.

LIGHT FOR VEHICLES' FOOTBOARDS.—A device to improve the visibility of the platforms of buses, tramcars, trolleybuses, and Green Line coaches is being fitted on the London Passenger Transport Board's vehicles at the rate of 1000 a week. The lamp has been approved by the Ministries of Home Security and Transport.

GOODS IN OPEN RAILWAY WAGONS.—To prevent congestion in the ports, the Minister of Transport has given instructions that railway companies shall convey goods in open railway wagons if neither covered wagons nor sheets are available, and congestion is likely to result if the goods are not immediately dispatched. The Minister has also made an Order under the Defence Regulations, relieving a railway company from liability for damage to merchandise carried unsheeted in accordance with the Minister's instructions.

FEN ROADS.—An inquiry of the Ministry of Agriculture and Fisheries has disclosed the fact that considerable areas of fenland are at present derelict, or in a low state of cultivation, owing to the absence of good roads. If suitable roads should be constructed as soon as possible, much fertile land might make a considerable contribution to the food production campaign. Work on the first scheme began some weeks ago and the contract has been scheduled as urgent works, thereby ensuring the release of the necessary supplies of reinforcing steel, cement, and gravel.

STALIN AUTOMOBILE WORKS.—The Stalin Automobile Works in Moscow has completed the building of a new wing for repair departments, the area of which is six and a-half times greater than that of the existing repair shops. Special Röntgen apparatus has been installed in the new wing for the examination of metals. The thermic department of the new wing is equipped with the most up-to-date furnaces and automatic devices for the regulation of temperatures. The new wing has ten powerful bridge cranes, 450 machines, furnaces, chambers and other equipment aggregating in capacity over 2500 kW.

AN ALASKA, B.C., PROJECT.—Canadian engineering journals are devoting fresh attention to a scheme to link up British Columbia with Alaska, by means of a great highway. It would link up with one of two railheads, Hazelton or Finlay Forks, both existing tracks on the Vancouver-Prince George Railway. At the northern extremity is Fairbanks, on the Valdez-Circle Alaskan Railway. A Canadian Commission is examining all available routes and to date it has been determined that the existing highway from Vancouver to Prince George, a distance of 525 miles, is available. After that two routes have been considered and they have been examined both from the air and on the ground. Further examination will be necessary before a decision can be reached. These routes for convenience are designated as the "A" (westerly route), Prince George to Alaska *via* Hazelton, 1442 miles, and the "B" route (easterly), Prince George to Alaska, 1223 miles.

Air and Water

LOSS OF SUBMARINE.—The Secretary of the Admiralty regrets to announce that H.M. Submarine "Phœnix" (Lieut.-Commander G. H. Nowell, R.N.) is considerably overdue and must be considered lost.

BRITISH INSULATED'S SPITFIRE.—In appreciation of the magnificent work of the R.A.F., the employees of British Insulated Cables, Ltd., have decided to provide a Spitfire. The company has assisted in this patriotic venture by subscribing to the fund an amount equal to the total subscribed by the employees, and a cheque for £5000 has accordingly been sent to the Minister for Aircraft Production.

LAUNCH OF THE "PRESIDENT JACKSON."—A steamship, the "President Jackson," has been launched by the Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia. It is the first of a fleet of seven "Presidents" being built for the round-the-world service of the American President Lines. She will have accommodation for ninety-eight passengers, an overall length of 492ft., breadth of 69ft. 6in., speed of 16½ knots, and is of 9300 gross tons.

DEMOLITION FOR SCRAP.—At the instigation of the Director of Scrap Supplies, Ministry of Supply (Iron and Steel Control), steps are being taken to demolish disused factories and warehouses, so as to reclaim the metal for conversion into war materials. The premises first taken over is a boiler shop in Beaufort Road, Birkenhead. The land is owned by the Liverpool Corporation and the building by Cammell Laird and Co., Ltd. The structural steel recoverable is estimated to amount to 125 tons.

INSTITUTE OF MARINE ENGINEERS' EXAMINATIONS.—Examinations for admission to associate membership and graduateship of the Institute of Marine Engineers will be held on May 19th to 26th, 1941. The Institute's examination for admission of students is discontinued, the Council having adopted in lieu the Common Preliminary Examination of the Engineering Joint Examination Board. Two of these examinations will be held in 1941, on April 1st to 5th, and on October 7th to 11th. The examinations are held in London and other centres in Great Britain. Full particulars of the syllabuses, exemptions allowable, copies of previous examination papers, and latest application dates, may be obtained on application to the secretary of the Institute, 73, Amersham Road, High Wycombe, Bucks.

SHIPBUILDING IN AUSTRALIA.—The Broken Hill Proprietary Company, the chief producer of steel in Australia, has laid down the keel of the first ship, to be built at its new shipbuilding yard. Another keel will be laid down shortly.

DEATH OF AN ITALIAN NAVAL DESIGNER.—Luigi Orlando (one of Italy's foremost naval designers) died at Rome on August 22nd, aged fifty-three. During the last war he designed and constructed the first fast motor boat for the Italian Fleet, and since then had planned several warships built in Italian shipyards for foreign account.

POWER PLANT FOR ONTARIO.—Plans have been drawn up by the engineering staff of the Hydro-Electric Power Commission of Ontario for a power development at Musquash River, Ont. The new plant is to develop from 10,000 H.P. to 12,000 H.P., and it is estimated it will cost in the neighbourhood of 1,000,000 dollars. It will serve the districts of Barrie, Collingwood, and Meaford.

SHIPBUILDING YARDS RE NAMED.—Harland and Wolff have recently re-named some of their yards at Belfast. The former Main Yard is now known as the Queen's Yard, a name derived from the Queen's Island on which the whole establishment stands. The South Yard takes its new title, Abercorn Yard, from the Abercorn Basin adjoining; while the East Yard has become the Musgrave Yard, from the channel of this name. Another small yard has been christened the Victoria Yard from the Victoria Wharf, one of the riverside fitting-out basins.

THE U.S. MARITIME COMMISSION AND APPRENTICES.—Another training station for apprentice seamen on the Pacific Coast at Hueneme, near Oxnard, California, has been established by the U.S. Maritime Commission. Hueneme is a new port recently constructed by the Oxnard Harbour District, at a cost of 1,750,000 dollars. It is served by the Southern Pacific Railroad. The harbour has a mean depth of 30ft., and is protected by a chain of islands lying offshore, and by two breakwaters. It is situated about 60 miles north of Los Angeles.

MERCANTILE LOSSES.—Mercantile losses due to enemy action for the week ended September 1st/2nd, 1940, were:—British, eleven ships, total tonnage 56,020; Allied, five ships, 15,038 tonnage; neutral, four ships, 13,517 tonnage, making totals of twenty ships and 84,575 tons. The total tonnage lost is in excess of the average weekly loss since the commencement of hostilities, but again below the average weekly loss for the period of intensified activity since May 27th, 1940. For the week under review, the enemy claims to have sunk 243,671 tons of shipping, which is very nearly three times the actual recorded losses.

SHIPBUILDING IN U.S.A.—The American Bureau of Shipping reports that ships under construction at United States shipyards on July 1st, 1940, amounted to 291 vessels aggregating 1,566,660 gross tons, compared with 295 vessels aggregating 1,516,185 tons on June 1st, and 122 vessels aggregating 630,340 tons on July 1st, 1939. These ships are all being built according to the Bureau's specification, but five other ships aggregating 38,250 tons gross are under construction, as well as three 10,000-ton tankers for the United States Maritime Commission and four 9600-ton tankers for the Texas Company.

A NORTH CHINA SCHEME.—For the development of the resources in Jehol Province and North China, particularly East Hopeh, and also to meet the rising demand for electric power by various enterprises, a plan has been drafted by the Manchoukuo Government in concert with the North China Provisional Government for a large-scale hydro-electric project on the River Lan, which flows from Jehol into North China, across the Great Wall. An investigation has been made by the Manchoukuo Hydro-electric Construction Bureau, and the survey revealed that there is available 800,000 kW of power at eight points on the main stream of the river.

U.S.A. MERCHANT SERVICE.—The American South African Line, Inc., has ordered three C.3 cargo and passenger liners for service between United States Atlantic, South African, Portuguese East African, and East African ports. To meet the requirements of the South African export trade, special provision is being made for the carriage of frozen and cool chamber cargo. The vessels will sail monthly from New York. Four cargo liners, similar in rating, have been completed by the Federal Shipbuilding and Dry Dock Company for the United States Maritime Commission. They have been bought by the Lykes Brothers Steamship Company for its Gulf and Far East service.

Miscellanea

INDIA WILL TRAIN TECHNICIANS.—The Government of India is arranging for the training of 3000 technicians for war production work in accordance with recommendations of the Technical Training Inquiry Committee. It is estimated that 10,000 men will be recruited annually.

SILICOSIS IN FOUNDRIES.—The Swedish Foundry Workers' Union has investigated in 170 ironfoundries and 21 steelfoundries the incidence of silicosis. The inquiry covered 8500 members, and the results showed that 1·3 per cent. were affected, more particularly those employed in the steelfoundries. The inquiry is to be extended to cover workers in engineering works and other branches of the metal industry in collaboration with other unions.

AGRICULTURAL MACHINERY IN U.S.S.R.—Ten years ago the first Soviet combine-harvester left the conveyors of the Communard Agricultural Machinery Works in Zaporozhe (the Ukraine). This marked the beginning of an entirely new branch of industry in the Soviet Union, the building of combine-harvesters. Two years later a large department for combine-harvesters was opened in the Stalin Agricultural Machinery Works at Rostov. The manufacture of these machines was also begun by the Lyubertsy Agricultural Machinery Works near Moscow. To-day there are more than 180,000 combine-harvesters in the Soviet Union. Beginning with the production of a machine like the one employed in other countries, the industry of the U.S.S.R. has since built original models, some of them with headers, 40ft. to 50ft. wide instead of the usual 16ft. to 20ft.

DIAMOND CUTTING.—The war has led to the disorganisation of the diamond cutting and polishing industry, following the invasion of Holland and the inability of the industry since to establish itself elsewhere. Diamond interests are hopeful that cutting and polishing machinery ordered recently from the United States will shortly arrive here, and thus give the industry a chance to recover and deal with the mass of stones now awaiting treatment.

MALAYA BUSY.—Malaya's exports during the first half of this year were valued at £65,500,000 and total imports at £49,500,000. Exports to the United States, mostly tin and rubber, amounted to £32,500,000, while imports from America were £2,250,000, thus leaving a favourable trade balance. Malaya has accumulated for shipment large quantities of scrap iron which is an example of the diversity of the contributions that are being made by the different parts of the Empire.

GAS SUPPLY.—The Corporation of Glasgow hopes to supplement a contract with William Dixon and Co. for the supply of a large quantity of coke oven gas from the firm's blast-furnaces with another, under which James Nimmo and Co. will supply gas amounting to 500,000 cubic feet a day to begin with and increasing later to 1,500,000 cubic feet a day. The cost will be approximately 7¼d. per 1000 cubic feet of purified gas—less than half the cost of production at the Corporation's own gasworks.

ARSENIC AS A TIMBER PRESERVATIVE.—A Swedish mining company has a method of impregnation for timber which involves the use of arsenical compounds. The liquid employed undergoes a chemical change in the timber with the final production of zinc and chromium arsenates, which constitute effective protection against decay or the attack of insects. Arsenic-impregnated timber retains its mechanical qualities and assumes a greenish colour. Timber treated by this process does not take fire readily, and burns slowly. The cost of the method compares favourably with other processes.

PLASTICS TO BE CONTROLLED.—The Minister of Supply has appointed Mr. A. Vyvran Board to be Controller of Plastics. Mr. Board is at present the Controller of Molasses and Industrial Alcohol, which post he will continue to hold. The Control is being set up to regulate the consumption of plastics, which are being used in increasing quantities in connection with the armament programme. It will also co-ordinate the arrangements for the supplies of the principal raw materials used in these manufactures, the more important being formaldehyde, urea, phenol. cresol, cellulose acetate, nitro-cellulose, and rennet casein.

SUBSIDISED PIT PROPS.—To encourage the production of home-grown mining timber in districts remote from collieries, a transport subsidy is to be paid on long railway hauls in the United Kingdom and on sea freights from Ireland and Scotland. Certain adjustments have been made in the prices of home-grown mining timber, and for the time being the transport subsidy will not be payable on mining timber if delivered to mines in the counties of Monmouth, Glamorgan, Pembroke, Carmarthen, or Brecon. A subsidy of £1 per ton will be paid by the Timber Controller on all mining timber produced in Eire and consigned to collieries in this country.

RECONSTRUCTION OF MOSCOW.—A sum of 10,000 million roubles has been expended on the reconstruction of Moscow during the last five years. Ten new bridges have been built across the Moscow River. The Moscow–Volga canal was put into operation during the period. Improvements carried out to Moscow's thoroughfares include the asphalting of over three and a half million square yards of streets and highways. The Moscow Metropolitan Railway was built during the five years of the city's reconstruction. Work is in full swing on the reconstruction of the Yauza River, for which purpose a sum of 250 million roubles has been allocated.

Personal and Business

MR. A. Y. PLANT, who has joined the staff of George Cohen, Sons and Co., Ltd., and will have his offices at their Stanningley Works, near Leeds, is an expert in quarrying and mining plant. He was formerly with H. R. Marsden, Ltd., quarry engineers, of Leeds, and also, for a number of years with W. H. Baxter, Ltd., of Leeds, as technical representative.

THE BRITISH ALUMINIUM COMPANY, Ltd., informs us that as from September 30th, 1940, its temporary head office address will be Oakley Manor, Belle Vue Road, Shrewsbury, Shropshire. The telegraphic address, "Cryolite, Shrewsbury," and telephone number, Shrewsbury 4451, will be unchanged (telephone number for sales, planning and publicity departments, Shrewsbury 4474).

CANADIAN APPOINTMENTS.—Mr. H. M. Armstrong, of Fredericton, N.B., and a member of the engineering staff of the New Brunswick Public Works Department, is the new Chairman of an Inter-departmental Committee to Co-ordinate Canadian War Activities in the Province of New Brunswick. Also named a member of the Committee is Mr. G. A. Vandervoort, of St. John, acting chief engineer of the New Brunswick Electric Power Commission.

ACCUMULATOR MAKERS JOIN FORCES.—An Export Group, formed at the instance of the Export Council of the Board of Trade, has secured support from almost every accumulator maker in the country. Mr. D. P. Dunne, managing director of the Chloride Electrical Storage Company, Ltd., is chairman of the Group, the other members of the Committee being Mr. F. J. Holmes (Hart Accumulator Company, Ltd.), Mr. W. H. Denby (Chloride Electrical Storage Company, Ltd.), Mr. G. B. Page (Accumulators of Woking (1928), Ltd.), and Mr. A. H. Shaw (Young Accumulator Company, Ltd.). The offices are at 27, Bedford Row, London, W.C.1, and Mr. Edward Powell is secretary.